T, DECEMBER 30. 1937

FIRST AERO WEEKLY IN THE WORLD

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FLIGHT

The AIRCRAFT ENGINEER AND AIRSHIPS

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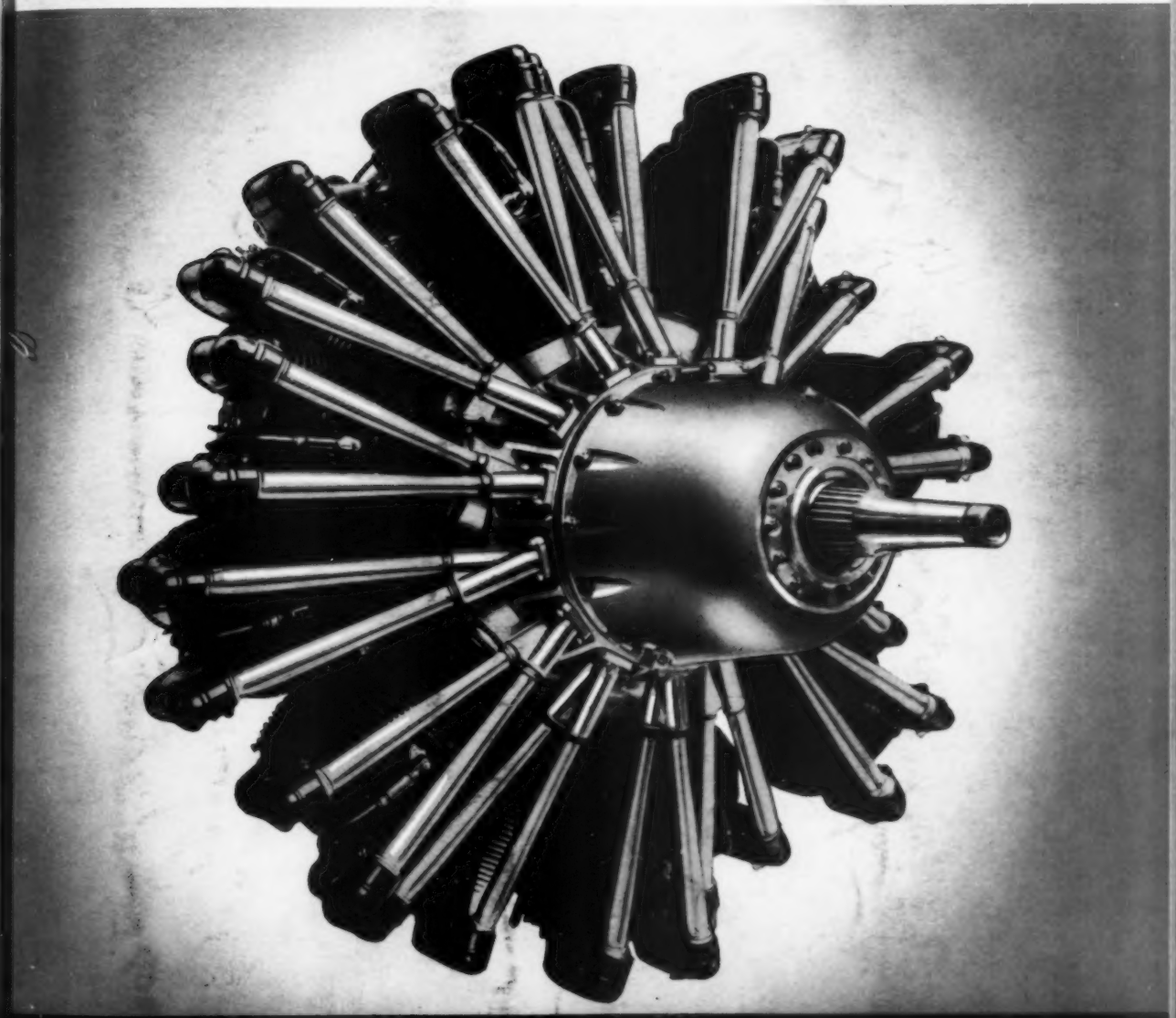

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FLIGHT

The AIRCRAFT ENGINEER AND AIRSHIPS

FIRST AERONAUTICAL WEEKLY IN THE WORLD : FOUNDED 1909

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The Outlook

Ring Out the Old!

IF the past year has produced nothing of startlingly outstanding moment in British aeronautics, at least it has been a busy year. There has been no standing still; we have been getting on with the job. Here we have been translating into fact the decisions of the past; there we have been laying the foundations for future advances.

Of actual achievements, the one great feat has been the recovery of the world's altitude record for Britain by Flt. Lt. M. J. Adam. That is a completely satisfactory triumph with which we are well content. Side by side with this solid entry in the credit column for the year must be entered the decision of the Air Ministry to form a Long-range Flight which will, we all hope, in due course add to Britain's laurels the world's record for a non-stop flight from point to point. Our former record-breaker, Wing Commander Gayford, is in charge of this flight, and that in itself is a good augury of success. The Wellesley, we believe, can do the trick, if something even better is not produced before the time comes to make the attempt.

The landplane high-speed record is, we believe, also within our powers, and we await the appearance of a special air racer, probably a legacy of that maker of Schneider winners, the late Mr. R. J. Mitchell. Some people still say that records belong to the spectacular side of flying, but those who think a bit more deeply know that they have a very real value, both from the research point of view, and also from that of telling the world that Britain is a force which cannot be neglected.

Ring In the New

IN civil flying the most interesting efforts of the year have been the institution of the new Empire mail scheme on the Africa airway, the substitution of Durban for Cape Town as the terminus, the use of flying boats instead of landplanes, and the carrying of letters at a minimum rate of 1½d. without surcharge. By this time next year the same scheme ought to be in operation on the route to India and Australia, and we shall be looking forward to an extension to New Zealand and on to Vancouver. Meantime, Canada is working to get her airway from the Pacific to the Atlantic into working order so as to be ready with the link which will enable British air lines to girdle the world.

On the Atlantic we have made progress with our plans. *Caledonia* and *Cambria* have done right well all that was asked of them. They have flown the Atlantic to and fro a number of times according to schedule, and have transformed that operation from a death-defying stunt into a safe and almost prosaic bit of route flying. *Cavalier* has done the same on the route between Bermuda and New York. We cannot yet say that the commercial prospects of the Atlantic air route have been proved, but at least we have made some notable steps in that direction.

Still we await the other experiments with *Maia-Mercury* and with the Albatross class of landplane. They may open new possibilities, and when the time comes to write our reflections on the year 1938, we may have learnt some useful lessons from those machines. It is a good thing, at the end of a year, to have some definite plans laid for the next year. That adds spice to life.

And Air Power

FOR the Royal Air Force also the past year has been one of getting on with the job. In expansion and in re-equipment it has been a sequel to the last two past years. Things might perhaps have moved faster, but they have certainly been moving. The number of new squadrons has gone on increasing, and at the same time many of the new types have actually been supplied to the operational units. Gladiators, Battles, Blenheims, Whitleys, Harrows, Wellesleys are now standard equipment for various squadrons, and the new era is marked by the camouflage colours which they now sport. Next year, we hope, will see the disappearance of the remaining obsolescent types which are still in use.

And, next year we hope to be able to record that the

air garrison at Singapore represents the *crême de la crême* of what our designers can supply. While the Far East is convulsed, as it is just now, it is very necessary that Singapore should have nothing but the best, and plenty of that best.

The Shadow Industry is not a conception of the year that is now drawing to its close, but 1937 has seen it spring into life in a way that is little short of marvellous. Britain has always felt sure of herself in the matter of design, but some time ago there was a very uncomfortable feeling about our powers of production. Now that misgiving has been removed, and, if the worst should happen, Britain can now face an emergency as a strong man armed, keeping his house.

Production

THE past year has been pre-eminently one of production, most of the aircraft and engine types which have come into general use having seen the light of day in prototype form before the beginning of the present year. Stressed-skin construction can be said to have been established firmly in that large numbers of machines have been built and the manufacturing technique mastered. Experience in the field is still needed before one can express an opinion of how these monocoque and semi-monocoque structures compare with the old girder types from the maintenance point of view. Just as the oldest-of-all type, the wood-with metal-fittings kind, was easier to repair than the steel tubular and strip steel combinations, so it may be that the new stressed-skin structures may present certain maintenance problems. Put differently, it seems reasonable to suppose that the stressed-skin constructions will need less frequent overhaul, but that when they do need it, the job will be rather more difficult.

No one particular side of metal construction appears to have ousted others, but perhaps there has been discernible during the year an increasing tendency towards the use of extruded sections, a form in which the light alloys have particularly useful mechanical properties apart from the relative ease with which these sections can be fastened to the rest of the structure.

The question of supply is likely to loom fairly large during the coming year, and this fact rather than the output capacity of our factories may set the limits to production.

Plastics

IF consolidation rather than innovation has been the keynote in metal construction, the same cannot be said of the relatively new field which may be described briefly by the word plastics. Here the year has been one of experimentation rather than application, and some very interesting results have been obtained. Curiously enough, the latest tendency is not so much towards mouldings, where the question of cost of large presses is the important factor, but rather in the direction of combining wood with synthetic resins. If the present rate of progress is maintained, 1938 may well see a return to wood for a number of purposes, not in the form in which we knew it in the early days of flying, but improved and made more homogeneous by the processes now being developed. Should that ambition be realised, wood may yet relieve the pressure on certain metal supplies, apart from any other advantages which it may be found to possess.

Far-East Fortress

SINGAPORE was once described by Rudyard Kipling as Britain's "richest roadstead," but of late years it has become a great deal more than that. When the naval and air base there has been completed it will be the centre of British power in the Pacific, situated sufficiently far east to protect British interests in that part of the world, but not so near to Japan as to constiute an irritating challenge to that martial nation. Mr. Hector Bywater, writing in *The Navy*, says that Singapore "does not, and cannot, hold any threat for Japan unless she has designs on the rich East Indian territories over which the new British base stands guard. In that event Singapore would indeed prove a formidable obstacle, provided that it gave shelter to a battle fleet."

Such a naval base must be well equipped with aircraft, and shore-based aircraft, not merely ship-borne machines. At present there are stationed there two general reconnaissance squadrons with Singapore III flying boats, two torpedo-bomber squadrons with Vildebeests, and the local Volunteer Air Force. The Sultans of the Federated Malay States are putting up the money to pay for three more R.A.F. squadrons to be stationed there. It may well happen that the Air Ministry will make a further addition to the air garrison.

It is of the utmost importance that all the squadrons should have the very latest types of aircraft, and that point most certainly has not been overlooked.

The good people of the Colony are also very much alive to their position, and a committee has been formed to take precautions against air raids. It is expected that this committee will be able to spend a hundred thousand dollars annually on its precautions, and a Bill has been introduced into the Legislative Council which is to make "black-outs" legal in case of emergency or for exercise and practice. This suggests that it would not be inappropriate to station a couple of fighter squadrons at Seletar, for air-raid precautions are of little use without fighter aircraft. But, of course, the great object of the forces at Singapore must be to prevent any enemy from getting to close quarters. For this a strong naval force, and long-range reconnaissance aircraft, with a good turn of speed, must be the strongest form of protection.

Dive Bombing

THE letter from a correspondent, published on p. 642, who agrees with the views of Air Chief Marshal Sir Hugh Dowding on dive bombing referred to in *Flight* of December 16, forms a very useful commentary on a most interesting subject. Our correspondent's argument is that neither air brakes nor reversible airscrews provide practical solutions to the problem of preventing a modern "clean" aeroplane from reaching excessive speeds during a dive, and that it would be more economical to take the old-type biplane, which already has a high drag, and put a more powerful engine into it to get the high top speed.

It would seem that really the main point of the argument is the definition of dive bombing. Our correspondent interprets the expression as meaning vertical diving, or nearly so. Probably that would be the ideal, regarded purely from the bombing accuracy point of view. But in the R.A.F. the term is used to describe a much more modest steepness of dive, not more than 30-35 degrees from the horizontal. If that is deemed sufficient to make dive bombing worth while, the difficulties with the clean aeroplane are not quite so formidable as those with which our correspondent deals so convincingly.

Reciprocity

HOW much or how little is there in the recent announcement to the effect that, during his recent visit to London, M. Pierre Cot arranged with Lord Swinton for an exchange of technical information between their respective Ministries? One was under the impression that such an exchange had been in operation for many years. At any rate, at the Paris Aero Show a little more than a year ago people on the French stands were singularly well informed about British products, even those which were still on the official British Secret List, the existence of which latter was itself regarded as being secret until the Secretary of State for Air himself mentioned it.

Of course, one hesitates to assume that all that has happened is that somebody has realised at last that the information gets across anyway, and that it is merely a

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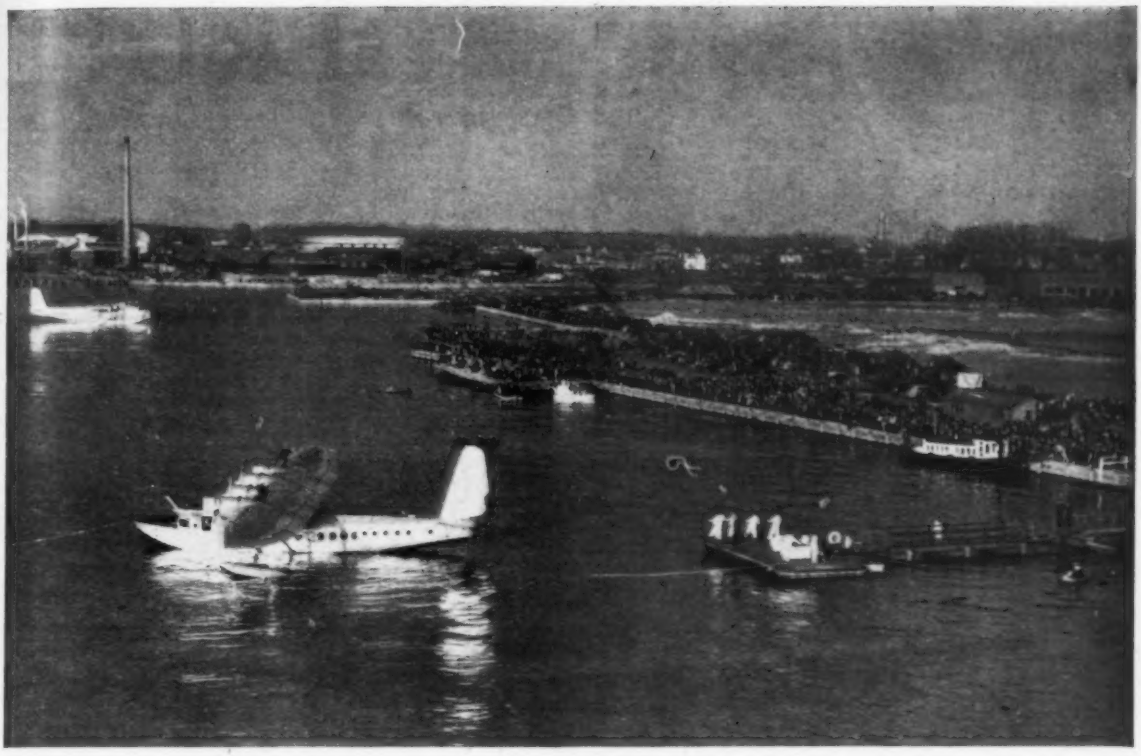

BALTIMORE INAUGURATION: Some of the crowd of 30,000 lining the banks of the Patapsco river to watch the recent inauguration of the new Baltimore Airport for landplanes and marine aircraft. It replaces New York as the terminus of the Bermuda route; the Sikorsky S. 42b *Bermuda Clipper* is seen being brought to the landing stage, and in the background is the Short Empire boat *Cavalier*.

question of establishing official channels for legitimatising the flow. One result should be that for information about the latest British aircraft products interested people will merely have to ask a French constructor.

The position could not be more ludicrous than that which arose in Germany some time ago. A bomber of a certain class was sold to a foreign air service. In Germany the bomber was still regarded as secret, but the purchaser saw no reason to treat it as secret, with the result that aviation journalists in every country except Germany could write full descriptions. German writers could do nothing about it.

"Paper" Aircraft

THE recent placing by Imperial Airways of a further order for flying boats of the Empire class brings the total ordered up to 39, far and away the largest order for civil aircraft ever placed with one British company by another. Short Brothers were originally given an order for 28 machines of this type, and it is significant that the order was placed before a prototype had been built and flown. In other words, Imperial Airways had to take what was, at the time, an extremely bold step and order "off the drawing board," as the procedure has become known since it was applied to R.A.F. expansion.

The benefits which are obtained by this system, if the machine comes up to expectations, have been strikingly illustrated by the fact that most of the 28 boats originally ordered have now been delivered. Had Imperial Airways adopted the usual cautious policy of having one machine built and tested before giving instructions to proceed with a large batch, it is fairly safe to say that not more than one or two boats would have been delivered by now.

Naturally, the system does not work so smoothly in every case, but that is a risk which has to be taken when the need for delivery is sufficiently urgent. Shorts proved themselves worthy of the trust. How important it is to order in large numbers at once is shown by the fact that the latest batch of boats ordered will take very much longer to build than the 16 days' period reached during production, and the first of the new batch will not, it is expected, be flying until some time during the summer, other work having been accepted and planned for in the meantime.

For all that, the achievement is one which reflects great credit on all concerned, and let it not be forgotten that Shorts, no less than Imperal Airways, took a chance in accepting the order. Had the first machine failed to come up to specification requirements in any important respect the financial result might well have been serious. The next step will now be to endeavour to foresee what sort of aircraft is likely to be needed to replace the Empire class when the time comes. We offer no prizes, but what are the guesses? Four, six or eight engines?

The Booking Ban

WITH the vast amount of amalgamation which has recently been going on in internal air transport (and which has probably been extremely necessary if the business is to be put on a really economic basis) there are very few operators outside the "iron ring."

However, it is at least comforting to learn that the North-Eastern Airways have now concluded negotiations with the Railway Clearing House for the removal of the booking ban, and that it is now possible for prospective travellers on this company's services to buy their passages in the ordinary way.

Flight has, during the last few years, repeatedly drawn attention to a state of affairs which has been both unfair and illogical. It is only a pity that it should be necessary, in this and in other disagreements between the ordinary person and the powers-that-be, to shout so loudly and, sometimes, to wave such a big stick before anything is done. In a civilised world it should never be necessary to demand the removal of injustices; they should be as quickly dealt with as they are quickly seen by everyone concerned.

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Aircraft and Engines Introduced During [illegible] *Twe*

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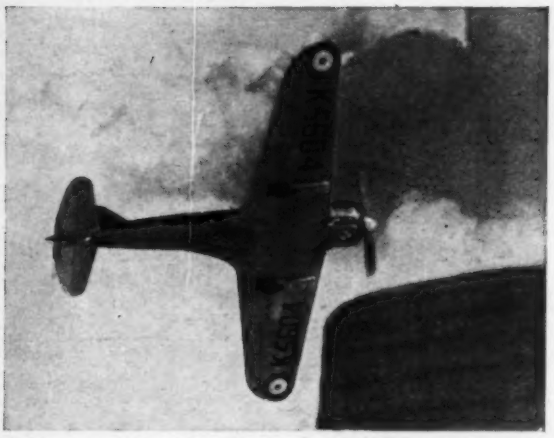
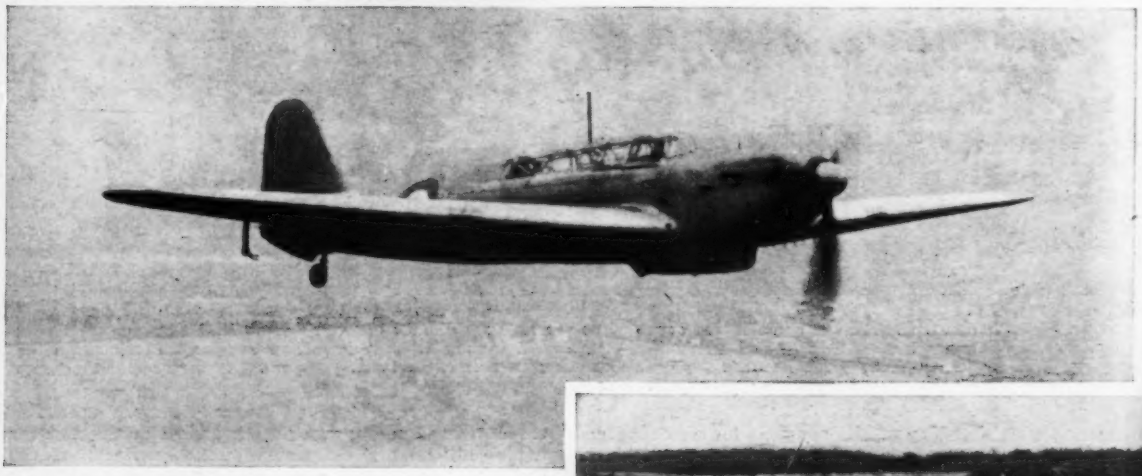




The Gloster F.5/34 single-seater fighter (top) and the Fairey P.4/34 light bomber (above) are two fine examples of 1937 military prototypes. The Gloster was designed for a Mercury or Perseus radial and the Fairey has the liquid-cooled Merlin. (*Flight* photographs.)

NINETEEN THIRTY-SEVEN has been a "production" rather than a "prototype" year, particularly on the military side, although, as the following review will indicate, some outstanding new aircraft have made their *debut*. The publication of performance figures for certain military machines and new engine types greatly facilitated the task of convincing other nations that, in many categories, Great Britain produces the finest flying equipment available to-day.

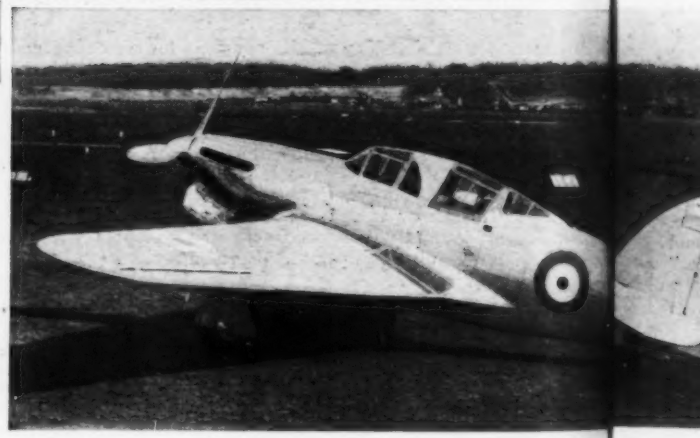
CIVIL AIRCRAFT

Indicative of the success of the Short Empire flying boats are recently announced orders for an additional eleven of these outstanding commercial craft, over and above the original contract for twenty-eight, most of which have passed into service during the past twelve months. The Empire boats, which have established themselves as the fastest and most efficient machines of their type in the world, have slid down into the Medway at Rochester at the rate of one a fortnight.

Likewise significant in the matter of Imperial communications was the completion of the first of fourteen Armstrong Whitworth Ensign four-engined landplanes. This machine will make an interesting comparison with the Douglas, Boeing, Junkers, Frocke-Wulf and Farman designs to meet somewhat similar requirements. Like the Empire boat, the Ensign is a high-wing monoplane, and as such will be particularly welcomed by passengers on whom the sight of a flexing metal wing beneath their windows is apt to pall.

The De Havilland Albatross, destined for a major rôle in British commercial flying, has been tested over a period of months. Technical advances characterising the Albatross include a cantilever wing of uncommonly thin section, new fuselage construction, and a novel cooling system for the D.H. Gipsy Twelve inverted-vee air-cooled engines, wherein air is taken in through orifices in the leading edge of the wing and led round the engine from the rear.

Technically, the high-light of 1937 was probably the



Ventral bomb stowage, ducted glycol radiator and a neat cockpit enclosure are features of the mid-wing Hawker Henley light bomber adopted during 1937 as a standard Service type. (*Flight* photographs.)

A fine example of a modern single-engined military trainer, the De Havilland Don, ordered in quantity by the Air Ministry, has the new Gipsy King engine. (*Flight* photograph.)

S of 1937

ing st Twelve Months : Looking Back on a Not ar

completion of both components of the Short-Mayo composite aircraft and the mounting of *Mercury* upon the back of *Maia*. Initial "combined" flights are imminent.

Marking the entry of the Percival concern into the twin-engined market, the prototype Q.6, recently announced, is a welcome addition to the range of British civil aircraft.

Development work has been proceeding, at the lower end of the size scale, on the Hordern-Richmond Autoplane and the Baynes Bee, two low-powered twin-engined types for the private owner. The Bee demonstrates a number of unorthodox features, including flat, buried engines working as pushers.

Production of the Miles Whitney Straight was under way early this year, and a machine of this type was chosen for the tests of the Villiers-Hay Maya engine.

The introduction of a B.A. Eagle three-seater monoplane with a fixed undercarriage as an alternative to the more usual retractable gear is not without significance. The resultant drop in performance is very small and the pilot has fewer worries.

Development work on the high-wing Wicko monoplane has included the fitting of the Cirrus Minor and Major engines. The Cirrus Minor engine is also specified for the Deekay Knight two-seater, which may eventually be "translated" into plastics.

Stressed-skin metal construction for the private owner has begun to come into its own with the introduction of the CW Cygnet two-seater monoplane which, aerodynamically as well as structurally, exhibits a number of refreshing features.

Sportsmen were particularly interested in the T.K.4 and the Miles Hobby, both designed around a similar engine—the Series II Gipsy Major—for the King's Cup Race. The ill-starred T.K.4 was a most enterprising effort on the part of students of the D.H. Technical School and was capable of an astonishing speed, considering its 135 h.p. The Hobby was rather more conventional, but a typically clean Miles monoplane.

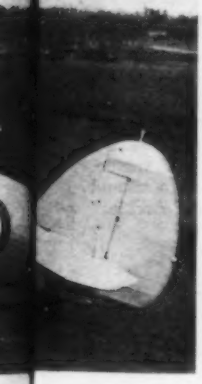
"Ultra-lights" of the year include the Dart Kitten, Luton Minor and Chilton monoplane, all commendable efforts to provide something cheap for the enthusiast.

And finally, though far from being a 1937 type, there is the "re-vamped" Comet which Essex Aero groomed for a magnificent performance in the Damascus Race and for Clouston's lightning Cape-and-back trip, and which did so much to help British aviation "keep its end up" in the eyes of the world during 1937.

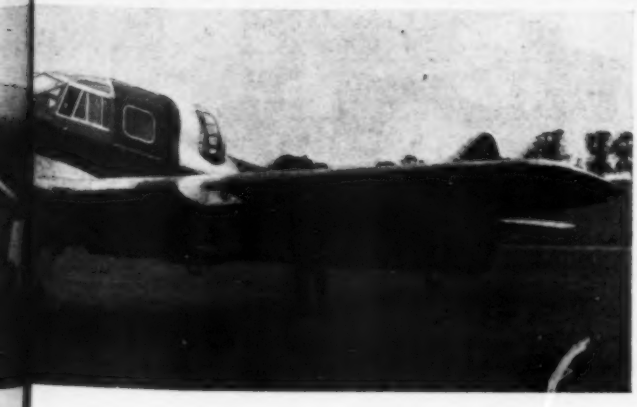
MILITARY AIRCRAFT

The military biplane is making its exit in a blaze of glory, the Gloster Gladiators issued to the R.A.F. this year being among the most popular machines ever adopted. With the Mercury IX engine the Gladiator does over 250 m.p.h., is a fine climber and extremely manœuvrable, and profits from the use of flaps. That the Gloster concern knows how to design monoplane fighters was obvious from the performance of the F.5/34 at the Hendon and Hatfield displays.

Profiting, like the Gladiator, by a Dowty single-strut undercarriage, the Yugo-Slav Hawker Fury with Rolls-Royce Kestrel XVI engine was a second outstanding



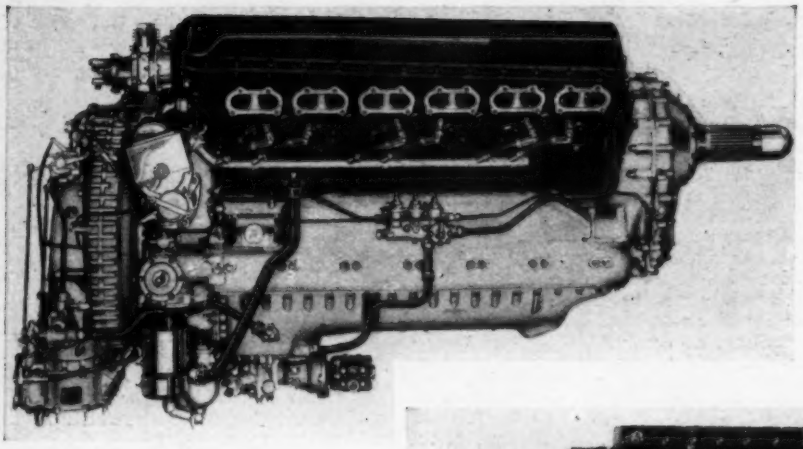
Capable of 295 m.p.h., the Miles Kestrel Trainer has great potentialities as a first-line military type. The engine is a Rolls-Royce Kestrel XVI.



biplane fighter. Improved armament was a feature.

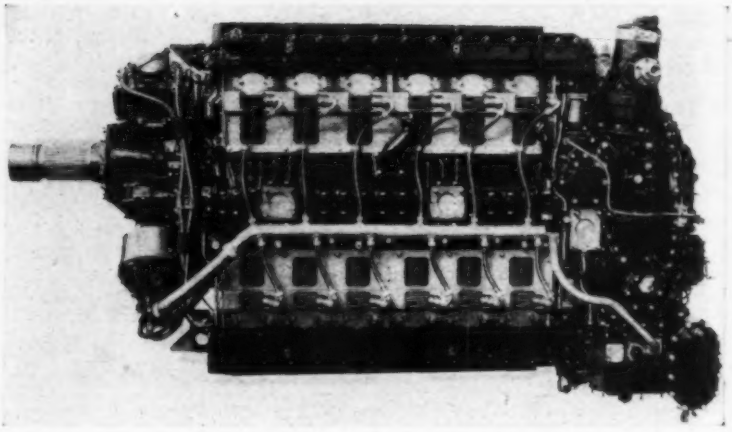
The year has seen the completion and testing of two light bombers—to the P.4/34 specification—by the Hawker and Fairey companies, the Hawker product, now known as the Henley, being ordered in quantity for Service equipment. In each case the engine is the Rolls-Royce Merlin. In the Henley the main bomb load is carried internally, but the Fairey, with its fuselage of small cross-section, has no such provision. Both machines are considerably smaller and lighter than the Fairey Battle, which does 257 m.p.h. with a similar engine.

First of a number of new Fleet Air Arm types, the Blackburn Skua dive bomber fleet fighter was put into production during 1937. Powered with the sleeve-valve Perseus engine, the Skua combines high performance with



(Left)
Equipping a large proportion of our latest fighters and bombers, the Merlin II, in large-scale production during 1937, is the most recent Rolls-Royce liquid-cooled unit.

(Below)
Two Napier Dagger E.108 24-cylinder "H-shaped" engines were specified during 1937 to power a new medium bomber to be built by Short and Harland.



features demanded for carrier operation, such as folding wings. Flaps are fitted not only to improve the landing characteristics but to aid in keeping the speed down in a dive. Technically, one of the most interesting departures is the unorthodox tail in which the fin and rudder are forward of the tailplane. Like the Shark T.S.R., the Skua has a watertight fuselage.

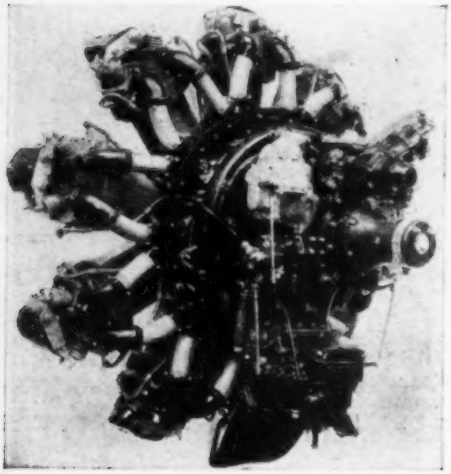
As the new types park at the R.A.F. Display bore witness, the year has been a bumper one for trainers. Miles, designing round the Rolls-Royce Kestrel XVI engine, conceived the 295 m.p.h. Kestrel Trainer, which, quite apart from being an admirable vehicle for the instruction of pilots for service in fighters and high-performance bombers, can be adapted for use as a general-purpose machine or multi-gun single-seater fighter.

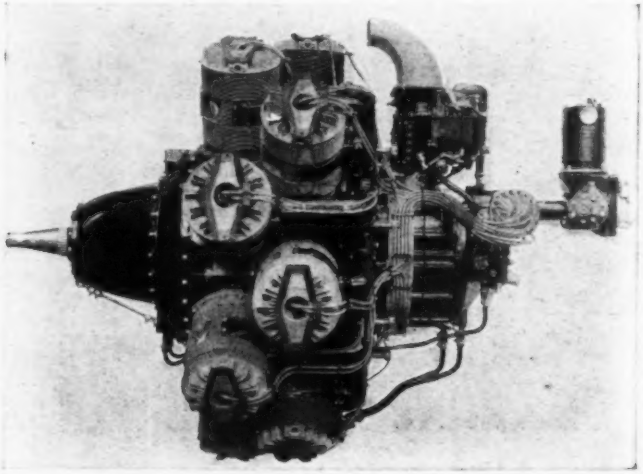
De Havillands produced the Don with Gipsyking (Gipsy Twelve) engine, and received a substantial contract from the Air Ministry for machines of this type. With its lower power the Don is not so fast as the Miles machine, but has the virtue of side-by-side seating. A gun turret and bomb racks are specified, and such refinements as a constant-speed airscrew, retractable undercarriage and the new D.H. cooling system are included.

For twin-engine training the Service will be issued with Airspeed Oxfords, the prototype of which appeared during 1937. Essentially a development of the Envoy, the Oxford has dual controls, provision for a gun turret and bomb racks, and mounts two of the new Siddeley Cheetah X radials driving D.H. v.p. airscrews.

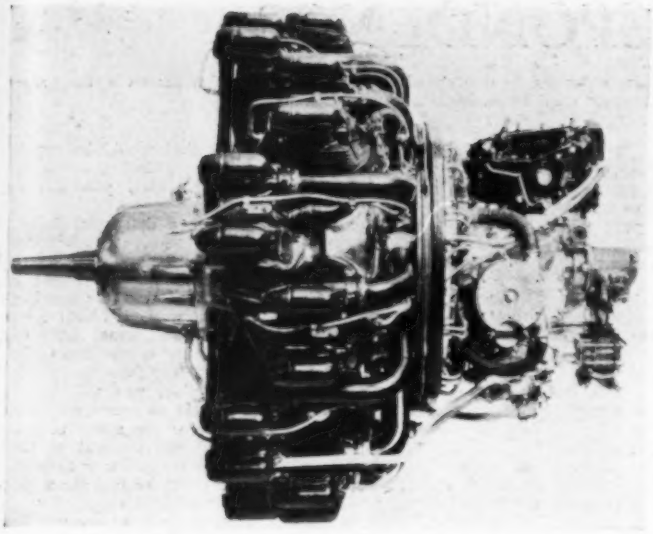
For *ab initio* work the Miles Magister was developed from the Hawk Trainer and adopted as a standard Service type.

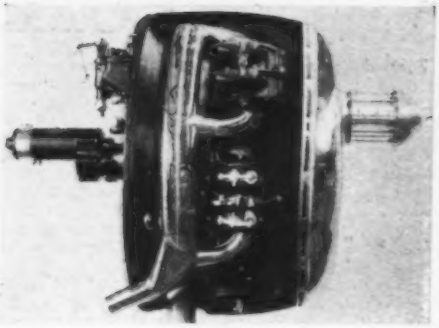
In response to a demand for wireless-controlled target aircraft of higher performance, Airspeeds produced the Queen Wasp floatplane with Siddeley Cheetah engine. Highly tapered wings and generally clean design should make the Queen Wasp a worthy target for any "Archie."





The Bristol Pegasus XVIII (left) is an advanced poppet-valve radial with two-speed supercharger. On the right is the two-row sleeve-valve Hercules, the most powerful type-tested radial in this country.





The Pobjoy Niagara V (above) delivers nearly 40 h.p. more than its forerunner, the Niagara III. It retains the characteristic Pobjoy features.

The Siddeley Tiger VIII (left) was the first two-speed supercharged engine to go into large-scale production. Engines of this type are destined for Whitley bombers.

As the year closes, the first Supermarine Spitfire and Hawker Hurricane fighters are coming through; Handley Pages have finished the Harrow contract and are passing on to Hampden medium bombers; Vickers are building special Wellesleys for the Long-Range Flight; and work is under way at the Short and Harland works on Bombay bomber transports and a version of the Hampden with Dagger E.108 engines.

ENGINES

Sources of power for high-performance prototype aircraft which, in several cases, were official secrets until this year, have now been revealed, and certain smaller units have branched out in new series.

Referring first to the low-powered units, early in 1937 the Series II Gipsy Six was introduced with the "1,000" size de Havilland v.p. airscrew. The continuous cruising power of this new model (205 h.p. at 2,400 r.p.m.) is a little higher than the maximum power of its forerunner the Series I engine. Later this year the 125-140 h.p. Series II Major appeared, having been developed along similar lines.

In the same class are the Cirrus Major 150, which embodies several improvements over earlier Majors, and the new Pobjoy Niagara V with bore increased to 81 mm., as compared with the Niagara III. The increase in output obtained by increasing bore and compression ratio and strengthening parts for higher engine speed is 35 h.p., the new maximum power figure being 130 h.p. at 4,400 r.p.m. For a capacity of only 3.14 litres, this output is very creditable.

A larger radial, the Armstrong Siddeley Cheetah X for v.p. operation, made its first appearance this year. A number of detail improvements over the Cheetah IX are noticeable.

A pleasing number of announcements have been made during 1937 concerning the high-powered units. In particular, the Bristol two-row Hercules completed type tests in moderately supercharged form, and was rated 1,150 h.p. at 2,400 r.p.m. at 5,000ft.

In common with other sleeve-valve models the Hercules has the new Bristol remote gear box for auxiliary drives. An American Northrop machine—a two-seater monoplone in rather the same class as the Fairey Battle—is being used as a flying test bed for the Hercules.

Two large radials with two-speed superchargers type-tested during the year are the Armstrong Siddeley Tiger VIII and the Pegasus XVIII. These, respectively, have their ratings at 6,200 and 12,800ft. and at 5,000 and 15,500ft. Both engines give an output of over 900 h.p. for take-off.

The Merlin II is Rolls-Royce's contribution to new types in the liquid-cooled class. The II differs in several ways from the I; in particular, it has the cylinder heads and barrels in one piece in blocks of six, following Kestrel practice. It has a fully supercharged rating of 990 h.p. at 12,000ft.

Finally, among the large engines is the Napier 24-cylinder E.108, a development of the Dagger, which, with a capacity of only 16.8 litres, gives quite an amazing output.

Still to be type-tested are the Alvis engines, introduced this year. All are high-powered, two-row radials known as the Maconides, Pelides and Alcides.

An engine worthy of special mention is the Aspin, which has been described in detail in *Flight*. The design is somewhat unorthodox, and engine speeds in the region of 10,000 r.p.m. have been recorded for continuous periods of running. The compression ratio of the 1,700 c.c. 80 h.p. model is 10.2 to 1, yet the engine runs on "straight" petrol using "soft" plugs.

Forthcoming Events

January 5. R.U.S.I. Lecture: "The Training of a Royal Air Force Pilot," by Air Vice-Marshal L. A. Pattinson. Royal United Service Institution, 3 p.m.

January 6. R.Ae.S Weybridge Branch Lecture: "Experimental Methods of Structural Analysis," by Prof. A. J. Sutton Pippard.

January 11. R.Ae.S. Isle of Wight Branch Lecture: "Aircraft Inspection Methods," by Mr. R. H. Longe.

January 13. R.Ae.S. Lecture*: "Radio as a Direct Aid to Landing Approach," by Sqn. Ldr. R. S. Blucke.

January 14. Strathtay Aero Club: Annual Ball.

January 18. R.Ae.S. Students' Section Lecture: "Turbulence and Skin Friction," by Mr. A. A. Hall.

January 19-21. Aerodrome Owners' Association: Airports London.

January 20. R.Ae.S. Portsmouth Branch Lecture: "Aircraft of the Future," by A. Hessel Tiltman.

January 20. R.Ae.S. Coventry Branch Lecture: "Installation of Aero Engines," by Dr. G. P. Douglas.

January 25. R.Ae.S. Isle of Wight Branch Lecture: "Bird Flight," by Capt. J. Laurence Pritchard.

January 26. R.U.S.I. Lecture: "Imperial Air Routes," by Lieut.-Col. H. Burchall, Royal United Service Institution, 3 p.m.

January 28. Northamptonshire Aero Club: Annual Ball at Salon de Dance, Northampton.

February 9. York and Leeming Flying Club: Annual dance, Grand Hotel, Harrogate.

February 10. R.Ae.S. Portsmouth Branch Lecture: "Cowling and Cooling of Radial Engines," by Dr. G. P. Douglas.

February 17. R.Ae.S. Coventry Branch Lecture: "Aircraft Motive Power," by Major E. F. Green.

* All these lectures take place at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1., beginning at 6.30 p.m.

CORRESPONDENCE

The Editor does not hold himself responsible for the views expressed by correspondents. The Names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

THE NEW AVIATION

I WAS intensely interested in aviation in its early days, and for some time I bought *Flight* regularly, commencing about issue No. 10. Unfortunately, I had to turn my mind to other things, and I have not kept up with the details of its progress since. Now, however, when I buy occasional numbers of *Flight* I am a bit puzzled by the direction in which aviation has developed.

The aim seems ever to be more and yet more speed, while economy in operation and safety take second place.

Would it not be worth while for the Government to rescue the industry from the pursuit of this single aim of speed by offering a large prize for the production and design of, say, a 40-seater three- or four-engined aeroplane built with the aim of economical operation—speed to be an entirely secondary consideration?

Such machines could be used for passenger excursion flights and for freight at cheap rates. They would be ideal for transporting supplies to inaccessible gold mines in jungle territory, and they could also be used for troop transport, as it is not always necessary, when transporting troops by air, to do so at 200 m.p.h. In fact, the design would have quite a large field of useful application.

Of course, the large aeroplanes of five years ago were pretty slow by present-day standards, but it seems to me that no one has ever yet designed a large machine solely from the operational economy standpoint, and that if it were done with present-day knowledge and experience the results would be excellent.

Turning to the smaller machines for private use, it seems to me that what is again required is a machine of moderate speed carrying three or four in an enclosed cabin and with the power divided up amongst at least three engines, which surely need not total up to 100 h.p.

Twenty-five years ago the problem of de-icing had not arisen, so will someone gently explain to me what is the snag in running an engine exhaust pipe inside the leading edge of a metal wing to prevent ice formation? Is it the proximity of the petrol tanks?

SLOW COACH.

London, N.4.

DIVE BOMBING

CONCERNING your Editorial comment on Air Chief Marshal Sir Hugh Dowding's reference to dive bombing (*Flight*, December 16), the A.M. have not called for the factors required for dive bombing because they would make the resulting aircraft useless for any purpose.

This can be deduced from fairly simple facts, to wit:—

1. Dive bombing is no use if the dive is not steep (70 deg. to 90 deg.)

2. Dive bombing is no use if you cannot dive at, at least, 300 m.p.h.

3. The modern bomber must fly level at 250 m.p.h. or more to be of any use.

It follows from 3 that if you are to have any reasonable ratio of military load to power and to full weight, the said bomber has to be clean.

The effect of the necessary cleanness on diving characteristics is difficult to realise unless you have some actual figures. Calculations for a modern clean aeroplane (less clean, however, than a bomber should be), show that her T.V. velocity would be about 650 m.p.h., that she could never get to this speed inside service ceiling, but that if dived from 30,000ft. to 6,000ft. vertically, she would take 90 seconds reaching 550 m.p.h. and could then just be flattened out clear of the ground at an acceleration of 4g. The change of pressure and the 4g would lay the pilot out, and you would have your diver doing 850 m.p.h. at G.L. with no conscious control.

So you can only dive the modern clean machine steeply if you use some kind of air brake.

Now in a vertical dive at a steady speed, drag must equal weight. If we take 70 deg. as steep enough, drag is still 87 per cent. of weight, so that if you want to keep your dive speed down to 300 m.p.h. you have to fit brakes which will make the total drag equal total weight at your dive speed.

But if your T.V. speed without brakes is 600 m.p.h., the machine drag, without brakes, at 300 m.p.h., is only quarter weight. That is, your brakes have to have a resistance at 300 m.p.h., equalling three-quarters of the weight, *i.e.*, three times that of the rest of the aeroplane.

Now a wing flap which had three times the drag of the whole (unflapped) machine at 300 m.p.h. would not be prohibitively big, but when you come to stressing it for a normal load of ¾ W., and the kind of factor that would be required to cover the case of the fool pilot who pulled it down in a dive when he found he was going too fast, you will find it is scarcely a practicable proposition.

The reversing airscrew is, of course, a delightful form of air brake on many counts. But to do the dive bomber job it has to produce a reversed thrust equal to ¾ W. If you take the kind of airscrew you would normally fit to a high-speed bomber for 250-300 m.p.h., you will find that the maximum thrust you can get out of it (the right way) is about 2.5 lb. per h.p., say ⅓ W. for a 7.5 lb. per h.p. aeroplane. In reverse you would get less, but neglect this; to get a maximum thrust (at maximum permitted r.p.m.) equal to ¾ W.—or 2¼ times as much as the normal screw could give, you will have to use a bigger screw. You will not be able to increase diameter (for you will already be somewhere near the speed of sound in your top speed), and your only hope is about 2¼ times the blade width which would probably throw away 15 m.p.h. in speed, and run you into 15 per cent. more fuel for a given range and speed on account of reduced efficiency.

But even this is a secondary matter. By the time you have stressed your screw for 2¼, the maximum thrust of the normal screw, it will weigh pretty certainly 2¼ to 3 times as much as the normal screw, and for a 1,000 h.p. engine your screw will weigh not far off 1 lb. per h.p. I don't know what the engine mounting would have to be like, but just ask any stress merchant what he would have to do to cope with gyroscopic couples due to such an airscrew.

If dive bombing has a sufficient value to justify an appreciable loss in the performance normally required from a bomber, then the dive bomber can most efficiently be a machine with a top speed about half to two-thirds of the required dive speed. If you want to dive bomb from anything much faster than this, you will, in practice, have to get your high speed by using an excessive engine power for the military load which it will carry. If it is a clean aeroplane with brakes, this will occur, because the structure weight required to cope with the brake loads will be colossal, and you will have to use a very large, expensive machine to carry very little useful load. And it would be more economical to take an old type biplane, which already had the drag required for diving, and put a big engine into it.

REALIST.

Staffs.

OBSERVATION

MAY I be permitted to correct a statement appearing under the subheading "French Army Co-operation" in "The Outlook" of December 16 last, on page 595, namely: "This suggestion shows the difference between French practice and our own in a matter of important detail. The French method is the one used by all the belligerents (including ourselves) during the Great War; the crew of an army co-operation machine consisted of a pilot and an observer-gunner. It was the latter who observed the fall of the shells and sent wireless corrections to the battery."

The practice of the pilot acting as observer and telegraphist was introduced into the Royal Flying Corps at least as early as 1916. During the battle of the Somme from July, 1916, onwards this was the preferred practice in my own Squadron, No. 34, although the choice of the alternative methods was left largely to the discretion of the crew of machines, and some teams of pilot and observer followed the older method in which the observer directed the fire of the battery; in fact, the choice of methods depended largely on the relative experience of pilot and observer.

In 1917 and 1918 the practice of the pilot directing the fire of the battery was almost universal. Not only was it found that observation of the target and the battery was facilitated when the "observer" could control his own movements all of the time, but that it was advisable for one member of the crew to be continually on the look out for enemy aircraft. The obvious person for this was the observer-gunner, especially after the introduction as standard army co-operation equipment of the R.E.8 and Armstrong-Whitworth machines, in which the pilot was seated in front.

I believe it is true that the British system (in which the pilot is the "observer") was never tried by the French or the Germans, but the systems of recruiting observers for the flying arm and the methods of fire control in use in the French and German armies were different from our own.

ARTOBS.

London, W.C.1.

GREETINGS—ATTRACTIVE and APPROPRIATE

Just a few of the hundreds of attractive and appropriate Christmas cards which *Flight* received last week from friends in every part of the world. All are heartily appreciated by the Editor and his staff.

COMMERCIAL AVIATION

OVERWEATHER : An impression through the port windows of the control cabin of a British Airways Electra flying in the sunshine at 9,000 ft. over what is probably a damp and dismal English countryside.

THE WEEK AT CROYDON

Christmas Day in the Air : Snow-plough Take-offs : Called to the Bar : "Works and Bricks" at it Again

CHRISTMAS Day was not celebrated in the air on most European lines. Imperial Airways served their famous Yuletide cheer on the previous day. On Empire routes, however, and on the K.L.M. Far-East route, Christmas Day was spent under way, and appropriate whoopee was made. Imperial's made provision in advance by sending a hundredweight and a half of turkeys and a hundredweight or so of plum puddings to various key points along the Empire route, together with other delicacies of the season, decorations, and so forth. Crackers are regarded as explosives by Air Ministry regulations and could not be used and they say that plum puddings suspected of collecting "static" in flight on account of the threepenny bits in them were fitted with trailing aerials to be wound in before consumption The Imperial Christmas menu sounds attractive. It reads as follows: Tomato cocktail, consomme Julienne, roast turkey with cranberry sauce, chipolatas, York ham, new potatoes, asparagus, Christmas pudding with brandy butter, cheese, biscuits, coffee, dessert and port. Thus, if the weather proved unpropitious the steward may have used the ancient adage, "Any port in a storm, sir?" On European routes the same menu was served, it is understood, on Christmas Eve.

Swiss Duplication

Swissair Christmas traffic has been exceptionally good. On the Wednesday, Thursday and Friday before Christmas, services with D.C.2 and D.C.3 machines were all duplicated to Switzerland and bookings on that route are said to be even better after Christmas. Holiday traffic in general is about up to normal summer season traffic, which, considering the wicked weather we have had this season, is really remarkable.

North-Eastern Airways have had difficult days owing to Perth Airport being snowed-up. I heard that Capt. Boitel-Gill had to requisition a horse-drawn snow-plough to make a runway, along which he was able to take off for Croydon. Incidentally, on the European routes, Stockholm has experienced the same sort of trouble this winter.

Cdr. Smirnoff, who has two million miles to his credit, broadcast from the B.B.C. last week. I now hear that an American pilot has laid claim to a higher mileage.

Capt. Hancock, who has been chief instructor of Surrey Flying Services and who has been with the company for seven years, is retiring from aviation in favour of keeping an hotel. Surrey's as well as his many friends here, will miss "Hank" very much, but it is the natural fate, it seems, of commercial air people on retirement to take a hostelry, or else to go and frequent one. A movement is on foot to induce sufficient ex Croydon Airport notabilities to become landlords for the others to go and be their guests, thus providing for all hands in their old ages. Don't say that aviation people must be that way inclined. It's just because of the abstemious life they have to lead that they have to do something about it when they retire.

Yuletide seems to have left a lingering flavour in the air around here, as though Works and Buildings had spilled a bottle of methylated spirit and strewn a few raisins around —or it may be that the Airport is so bracing and the queer spirituous smell is merely the ozone with which our breezes, roaring down Purley Way like the unrestricted traffic from the top of the hill, is impregnated. On the subject of this unrestricted traffic, "reaching gale force at times" past the "in" and "out" gates of the Airport, I notice that a most unusual and unfamiliar sign has been erected (and in road signs unfamiliarity breeds contempt). It is an oblong outfit on a stick about the size and shape of a newspaper poster and might very well be one. Anyone with leisure to read it finds that it says, with unnecessary verbosity, "Caution—30 m.p.h. limit applies." As the speeding motorist is on an unrestricted road and as the 30 m.p.h. sign, the normal disc, is some way down the road, albeit carefully masked by a cunningly aligned Burgin Beacon, what does this rectangular sign apply to, anyway?

Whatever the disc is meant to do it normally won't do because people won't notice it at all and if it is supposed to apply to the Airport exit gate, one hopes they won't. If they do, and apply their brakes suddenly they will merely pass the exit gate at, say, 60 m.p.h. in a sideways skid, possibly upside down, and the already dangerous and difficult life of Airport employees and passenger coach drivers will be a much more perilous one. It almost looks as if "Works and Buildings" (known here as Works and Bricks), had a finger in this remarkably third-grade pie. Already, for about a month, synchronising with the date W. and B. knocked off for Christmas (otherwise some repair would have been contemplated) the stout iron railings near the exit gate have been twisted into a true lovers' knot, with knobs on. Possibly one wrongs Works and Bricks, however, for Bricks can't touch ironmongery according to his contract and Works' job is to watch Bricks work. *Heil Stalemate!* as they say at the annual W. and B. banquet.

New Australian National Schedules

SINCE the end of October Australian National Airways have operated their Adelaide-Perth service three times a week in each direction, the schedules being completed in single days and the stop at Forrest being dropped. The long stage between Ceduna and Kalgoorlie is now flown non-stop, and meals are served in the air.

Incidentally, A.N.A. should by now have taken delivery of the D.C.3, though at the time of writing it is uncertain whether this company or its associate, Airlines of Australia, will put it into service.

Business Transport

ONE or two particularly interesting features of the Ju. 52 used for private transport by Bayer Products have not been given in previous references to the machine.

Among these is a relay system by which the passengers may apparently, through the medium of the normal radio transmitting and receiving equipment, talk with ground stations in telephony up to a range of 40 miles. In addition to the medium-wave equipment the machine carries a Lorenz receiver, D/F loop, and full blind-flying equipment, so that flights under all normal transport conditions may be carried out to schedule. The standard flying range is a matter of 1,250 miles, and oxygen equipment is carried for high-altitude work.

Still More . . .

A GOOD and inevitable feature of modern air transport operation is the education of passengers and prospective passengers in flying methods. The passenger who knows something about navigational systems, bad weather approaches and the reasons for high-altitude flying is likely to be a good deal happier than one who is entirely ignorant of such matters.

Swissair have just produced a very thoroughly informative booklet dealing with their operations and explaining in detail the means used by the crews to find their way above the clouds between Croydon and Zurich. There is nothing highly technical about the material used and the booklet is otherwise interestingly filled with well-illustrated articles on the different services operated by the company, with explanations of the maintenance systems, with a short history of the company and details of its fleet.

. . . Public Education

UNITED Air Lines of America have recently published a little book which tells the prospective passenger all the things not usually considered good for this person to know. Such matters as flight altitudes and barograph checks, cruising range, meteorological methods, static suppression, de-icing, and more domestic affairs such as guaranteed salaries for pilots, are dealt with in a way which suggests a new attitude of operating companies towards the general public.

Incidentally, United, along with one or two large American operating companies, has its own meteorological system, which is co-related with that of the U.S. Weather Bureau. Mr. H. B. Caster has recently been appointed director of meteorology for the company.

Christmas Loads

IT would seem that Imperial Airways and their associated companies must have beaten all load and distance "records" during the second and third weeks in December. In all something like 112,000 miles were flown during the week ended December 17 by thirty-two different machines, and this, taking an average load of 2 tons for each, produces a ton-mileage figure of 225,000. As the bulk of the mileage was flown by Empire boats, it is probable that even this is an underestimation.

Actually, no fewer than seventeen of these boats were flying during this period on the African and Mediterranean routes, and the only two units not in action were *Canopus* and *Cambria*, which were presumably undergoing maintenance at Hythe. The other machines in use included two of the Hannibal class, five of the Atalanta class, and eight 86's, five of which were flown by Qantas on their Singapore-Brisbane service. Incidentally, the second Short boat for this company has now been delivered.

Across the South Pacific

JANUARY 29 is given as the zero hour for the Pan-American Airways' service between San Francisco and Auckland, New Zealand. For a start the new service will be operated every fortnight and the actual Pacific crossing, *via* Honolulu, is expected to take three days. This means that, if all connections are made, mail will be carried from this country *via* the U.S. to New Zealand in eight and a half days as against five weeks or so by boat and about fifteen days by Empire service and steamer across the Tasman Sea.

Ultimately, the Empire service time to Brisbane will be reduced to seven and a half days, and when the Tasman Sea is crossed by air the whole journey should take only eight and a half days—exactly the same as the time suggested for the service *via* the U.S. Everything will then depend on the mail charges which will be made on the American route.

In the meantime *Centaurus*, which left Southampton on December 3, has now reached Auckland on its survey flight in command of Capt. Burgess, and the machine was moored beside the P.A.A. *Samoan Clipper*, which arrived the day before on its second survey flight across the South Pacific.

Berlin–Baghdad

DURING November D.L.H. opened a new service between Berlin and Baghdad. This is reserved exclusively for through traffic and is operated weekly each way with Junkers Ju 52's.

France and the North Atlantic

THE problem of the surface organisation for their North Atlantic service will be the main preoccupation of Air France-Transatlantique during the winter. Efforts are being made to arrive at a settlement with the Portuguese Government regarding the use of the Azores as a refuelling base, and also with the British authorities, from whom a reply is long overdue, concerning permission to alight at Newfoundland. The letter was sent last July.

The handicap resulting from the fact that these questions are not settled has already caused Air France-Transatlantique to abandon last season's projected North Atlantic trial flights, and the urgency of the matter lies in the fact that, until they are settled, the type, or types, of machine required must remain uncertain.

Blind Approaches at Liverpool

FOR some time a Marconi medium-wave approach beacon and its complementary markers has been in experimental action at Liverpool Airport. A *Notice to Airmen* brings the equipment, so to speak, into official use, gives some detailed information, and explains the institution of a five-mile-radius control zone on the customary lines.

Both the main beacons and the markers operate on a frequency of 355 kc./s. (845 m.), and the signals may be received on any standard medium-wave set. Furthermore, the main beacon may be used by the airport operator for communication with machines after permission to use this beacon has been duly granted by the Manchester control. The QDM of the beam is 259°, with dashes on the northern sector and dots on the southern sector outside the equi-signal line, and the distance between the outer and the inner marker beacons is 5 kms.

A blind approach may presumably be made, if preferred and with permission, from the QDM 79° side—i.e., over the Mersey estuary—though in this case, of course, no marker beacon aids are available. The call sign is MLA and the range is 25 miles with W/T and eight miles with R/T. Unfortunately (perhaps), it is still necessary, for the pilot with a homing receiver only must necessarily land somewhere else to obtain permission to use the system.

Jersey's Annual

EXACTLY four years previous to December 18, Jersey Airways started their services when machines, piloted by Messrs. Swiss and Caldwell (the latter now the company's chief pilot), made the journey from Portsmouth to the beach at West Park. At that time the staff numbered five. It now numbers about 100, and so far this year over 33,000 people have been carried.

These and other interesting figures were revealed at the second annual dinner of Jersey Airways, held at the Merton Hotel on the anniversary date and attended by over 100 employees and guests. Mr. J. A. Perree (President) occupied the head of the table, and there were present, in addition to the local guests, Capt. R. Stranger (chairman of the Southampton Airport Committee), Mr. Payne (manager of Southampton Airport), Mr. Lisney (Air Ministry Inspector) and Mr. Powell of the Air Registration Board.

The toast of "The King" having been proposed and honoured, Capt. Stranger proposed the toast of "Jersey Airways, Ltd.," referring to the success of the company which had been obtained without any Government subsidy, and speaking of the good feeling which existed between the Southampton and Jersey Airport staffs. Mr. L. T. H. Greig (manager and director), in reply, thanked Capt. Stranger for his kind references to the company, and went on to trace the development of Jersey Airways since they started four years ago. He stated that their associated company, Guernsey Airways, would start operations again when the Guernsey Airport was completed—in 1938 or 1939—and he believed the latter year would be one of big development in the company's history. The next toast, that of "The Press," was proposed by Mr. J. A. Perree. Mr. Vernon Rivers responded. Finally, Mr. Greig submitted the toast of "The Guests," the reply being made by Mr. Geoffrey Fenton (one of the company's most regular passengers).

After the speeches, which were brief and humorous, an interesting ciné film showing the Airways' development, was shown by Mr. Percy Wakeham, and there were also several cabaret turns.

Commercial Aviation

MORE BLIND APPROACH ASSISTANCE

INTENDED to give the pilot a properly orientated picture of the airport which is being approached in bad visibility, a new instrument is now being tested by the U.S. Bureau of Air Commerce. The prototype has been made out by the Sperry people and the idea is that of an American airline pilot.

The "airport orientator" shown as part of a specially modified directional gyro. In this case the circular chart is designed for American use and shows the disposition of the radio range beams.

The orientator, in which a circular chart may quickly be fitted for any particular airport, is directly connected to the disc member on the top of a directional gyro. The shaft supporting the disc extends up through the case of the instrument from the vertical gimbal ring and the chart is thus made a part of the gyro proper and does not interfere with the normal work of the instrument. In use, the directional gyro is set by the magnetic compass and thereafter the pilot sees the little plan of the airport just as he would in the ordinary way so long, of course, as the machine is flying towards it. In other words the device must necessarily be used in conjunction with radio compass, D/F, or blind equipment.

The chart can be designed to show the shape of the airport, the position of floodlights, the layout of the terminal buildings and any other information which normally appears in the mental picture which the pilot must carry during bad weather approaches. An apparent disadvantage of the device would seem to be that, once set, the gyro card must not be altered, and this fact would prevent the pilot from working, as he usually does, on the easily read zero mark. Nor are the advantages so obvious in European operations, since there are certain set lines of approach at every airport, whether the machine is being brought in on an ultra-short-wave beam or on the "ZZ" system. Every transport pilot who is as experienced as he should be on any particular route knows the correct approach line well enough to make such assistance almost unnecessary. In America, on the other hand, the approach may usually be made on any one of four radio-beacon "spokes" and the mental difficulties are considerably greater.

However, any scheme which relieves the strain on the pilot during a blind approach is worth consideration, and this particular idea might quite well be developed for use with specialised European approach methods.

Celestial

TABLES of sunrise, sunset, moonrise and moonset, which are included annually in both the standard and abridged editions of the *Nautical Almanac*, are now available in separate form from His Majesty's Stationery Office. This separate reprint will permit the users of the *Air Almanac*, which is, of course, intended to replace the *Nautical Almanac* for purposes of air navigation, to obtain the information they require without the duplication of other data. In 1939, for the first time, these tables will include separate computations of moonrise and moonset for southern latitudes.

"The Air Pilot"

AT long last a new impression of *The Air Pilot* (3rd edition) is being published by His Majesty's Stationery Office. This incorporates all the permanent information which has appeared in the monthly supplements issued between October, 1934, and September, 1937.

With the continually changing conditions relating to prohibited areas and to air traffic rules, *The Air Pilot* becomes a more and more important publication where both civil and Service pilots are concerned.

Air Law Simplified

Air Rule of the Road and Air Legislation, by Lt. Cdr. R. Sunnocks; 5s., Brown, Son and Ferguson, Ltd., 52-58, Darnley Street, Glasgow, S.1.

THE business of discovering exactly what one can or must do as a pilot, and of remembering all the signals and so forth, usually involves a stolid search through a large number of volumes and/or Air Ministry publications.

This little book sums up all the essentials, while giving chapter and verse for those who wish to go more deeply into the different subjects Furthermore—and this is quite important when an examinee is endeavouring to remember the different signals and control markings—it is copiously illustrated with multi-colour sketches showing diagrammatically all the signals and lighting arrangements with which the pilot is concerned. For instance, the range through which navigation lights must be exhibited are shown in diagrams which are not likely to be forgotten, whether one is thinking of landplanes, flying boats, balloons, airships or marine craft.

At the end of the volume the world's military aircraft markings are given in colour, and a set of not very good sketches gives the reader some idea of the appearance of the better-known Service and civil machines.

Whether one is requiring information on the documents to be carried, or the instruments to be used on different machines, on aerodrome signals and markings, or on the lights displayed by a navigable balloon which is no longer navigable, you will find it given in the minimum number of words somewhere in this handbook.

Remote Control

DURING the summer, while visiting Speke aerodrome, Liverpool, and looking over the new control tower there, we noticed a particularly good example of an airport lighting control panel which had only recently been installed.

This panel, which, with the bulk of the airport lighting equipment, has been installed by the General Electric Company, is in desk form. A plan of the aerodrome is engraved in the facia panel and this is orientated so that the control officer in charge sees the plan as he might be seeing the aerodrome itself, were this possible. Each airport light, including the wind tee, has its miniature on the desk and when switched on a light appears on the plan.

At the bottom right-hand corner are all the switches which may be needed and in the centre is a dial which reproduces the position taken up by the wind tee. This tee may be fixed in any desired position for flat calm conditions.

A Year's Progress

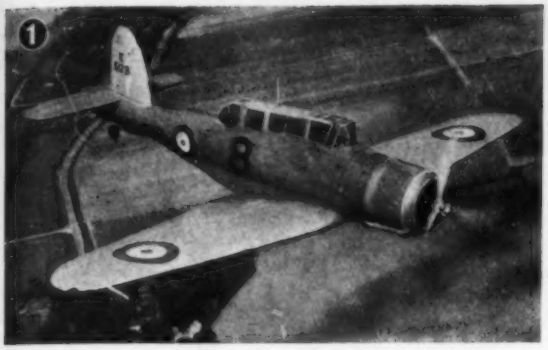
Report on the Progress of Civil Aviation, 1936; 5s., His Majesty's Stationery Office.

ALTHOUGH the study of a year-old report may appear to be rather lost labour, there are, in fact, a large number of interesting points to be gathered from the study of this annual publication.

Most interesting of all, perhaps, are the sections devoted to radio communication and the work of the meteorological department, though the information about the transport companies, clubs, schools, and miscellaneous enterprises is always likely to be useful for reference purposes. Concerning the radio position, it is significant to notice that the report suggests that it will not always be practicable to prevent the possibility of accidents by normal traffic control methods, and that some form of anti-collision device, possibly on cathode-ray lines, will eventually need to be developed. The use of omni-directional radio beacons from which bearings may be taken is also mentioned, with reference to the particular value of a number of these, placed at different points, in enabling the pilot to obtain a definite position without demanding the assistance of the ground stations. The report "awaits with interest" the outcome of the World Tele-Communications Conference to be held at Cairo in February, 1938.

The sections devoted to the trans-Atlantic air service and to the investigation of accidents are not likely to be of any great interest now that we have almost reached the year 1938. Nevertheless, it is surprising to see that among the number of accidents only eight occurred to machines on regular transport service, while fifteen occurred to privately owned machines. Club and school flying accounted for nine only—which rather points to the sobering effect of regular instruction and supervision. Rather more than 50 per cent. of the accidents were attributed to errors of judgment.

The statistical figures and the maps given at the end are at least of considerable historical value.



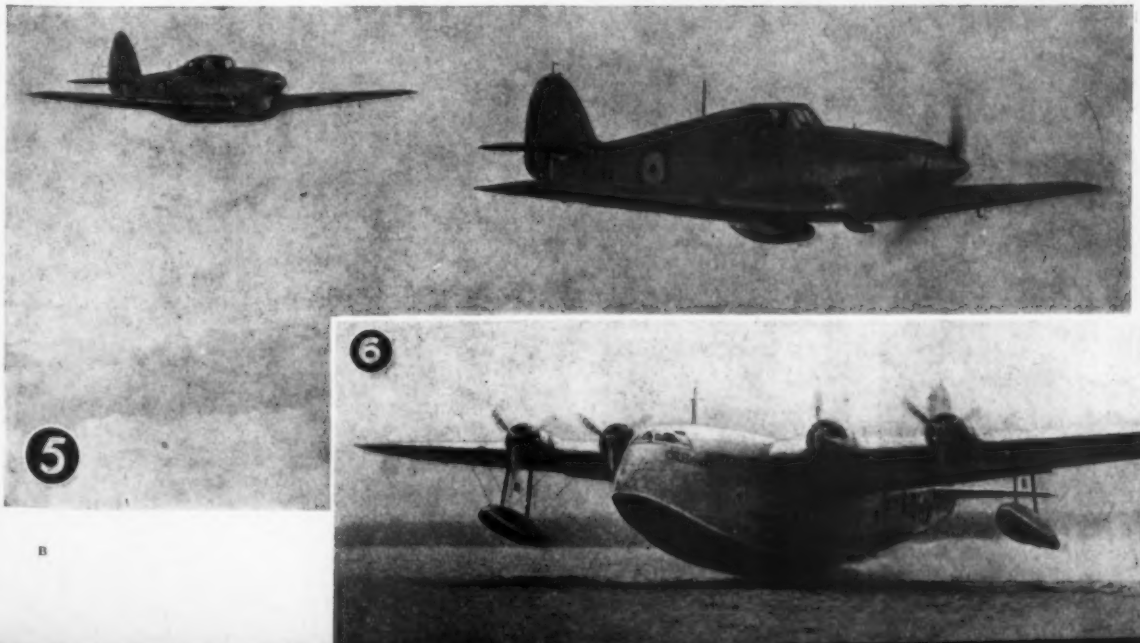
THE YEAR

JAN. : FEB. : MARCH

TWO important and closely allied announcements narrowly missed a 1936 birthday and, instead, lent a hand in sending off 1937. The De Havilland Gipsy Six Series II engine was announced, and at the same time the 1,000 size D.H. v.p. airscrew which it is designed to drive. Then there was an achievement which, occurring on December 30, almost fell between two years—Mlle. Bastie's recapture of the South Atlantic record from Miss Batten. Late in January the private flying world received important news in the announcement that the first production Miles Whitney Straight (picture 2) had appeared.

February saw the first flight of the Hafnir gyroplane (4), and in the sporting news was the name of Howard Hughes, who, in his special racing monoplane, averaged 332 m.p.h. between Los Angeles and Newark, New Jersey. The industry was occupied with the B.I.F., and commercial aviation was proud of *Caledonia's* (6) 2,300-mile flight to Alexandria. Military aviation saw the Blackburn Skua dive bomber (1) for the first time and the first production, enclosed-cockpit Gloster Gladiators (3).

In March information began to leak out about the Hawker P4/34, or Henley (behind the Hurricane in picture 5), with Rolls-Royce Merlin engine. The Baynes Bee twin-engined pusher monoplane appeared. Sir Philip Sassoon introduced the largest Air Estimates ever announced in the House. Jersey Airways terminated beach landings with the opening of their new airport in March.



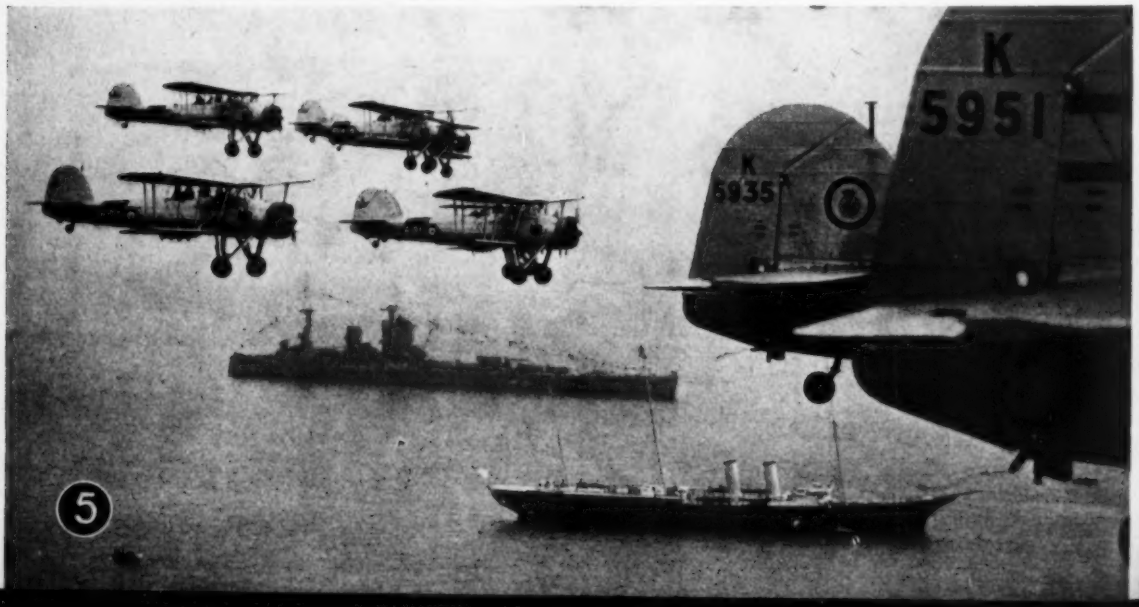
The Year (Cont.)

APRIL : MAY : JUNE

FULL details of the Armstrong Whitworth Ensign for Imperial Airways appeared on April 1. Activity in military circles was considerable; Blenheims and Wellesleys appeared in "dazzle" paint, Supermarine Stranraers also reached production, and the Fairey P4/34 and Wellington showed their paces. Two Japanese flew their Mitsubishi monoplane from Tokio to Croydon. The de Havilland Albatross (2) faced the camera in April and taxying tests commenced. The aircraft carrier *Ark Royal* (picture 1) was launched at Birkenhead.

The Coronation occupied all our thoughts at the beginning of May, but the C.W. Cygnet two-seater Tipsy and Scheldemusch claimed headlines. Flown by Lt.-Col. Mario Pezzi on May 7, an Italian Caproni 161 established a world's height record of 51,348ft. The Fleet Air Arm fly-past at the Naval Review (5) was the Royal Air Force contribution to Coronation celebrations. Three events to be remembered were the arrival almost together of record-breakers Broadbent and Brook from Australia and South Africa respectively and the inauguration by *Cambria* of the England-Durban through service.

June and flying usually go well together; the Isle of Man race, however, was flown in rather difficult conditions. Hector and Blenheim Squadrons (4) were in the news and among important new types were the Gloster monoplane fighter (3), the D.H. Don, and the Miles Kestrel XVI trainer. The Bristol sleeve-valve Hercules was rated at 1,375 h.p. at 4,000ft.



The Year (Cont.)

JULY : AUG. : SEPT.

SPECTACULAR flying, as exemplified by the S.B.A.C. Display, followed on the heels of the Royal Air Force Display—attended by the King and Queen (picture 3)—reached its peak early in July. The Airspeed Queen Wasp made its first public appearance. On July 1 it was announced to the world that on the previous day Flt. Lt. Adam had recaptured the world's height record (53,937ft.) on a special Bristol monoplane (5).

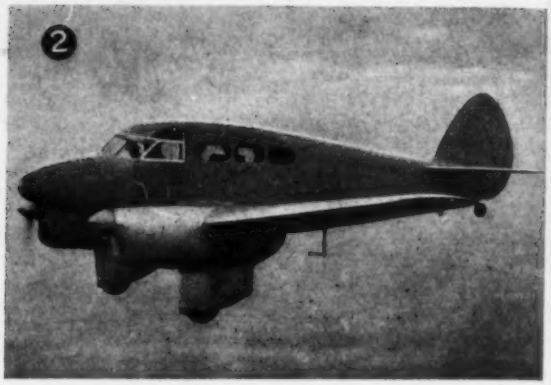
On Monday, July 5, *Caledonia*, Imperial Airway's long-range Short flying boat (6), made her initial crossing of the North Atlantic from Foynes to Botwood, a distance of 1,993 miles in 15 hr. 3 min. The Pan American Sikorsky S.42.B boat (6) reciprocated.

Delivery commenced of Fairey Seafox light reconnaissance seaplanes (4) with Napier Rapier engines.

Leaving Moscow on July 12, three Russians flew non-stop over the North Pole to California, 6,650 miles (62½ hours), in their A.N.T.25.

August saw the completion of the King's Airspeed Envoy and the ill-fated D.H. T.K.4. For the Mayo Composite machine (2) the lower component was flight-tested and the upper receiving finishing touches. Details of the Armstrong Siddeley Tiger VIII with two-speed blower were released. Towards the end of the month Italy won the Paris-Damascus Paris race with three tri-motor Savoia-Marchetti S.79's. England's one entry, the D.H. Comet, flown by F/O. A. E. Clouston, came in fourth. Lympne held its fifth International meeting.

The big event early in September was the King's Cup Race, won by Mr. Gardner's Mew Gull (1). Details of Rolls-Royce Merlins I and II were released.



The Year (Cont.)

OCT. : NOV. : DEC.

DURING the first weeks of October interest was centred on the Milan Aero Show. At home, the Monospar with tricycle undercarriage (picture 5) was undergoing tests. General Milch and officers of the German Air Force inspected our latest equipment and shadow factories.

Miss Jean Batten (4) arrived in record time (5 days 18 hr. 15 min.) from Port Darwin on her Percival Gull, thus becoming holder of outward and homeward Australia records.

Following the Germans' visit, an officially conducted Press visit to shadow factories (3) was permitted at the end of October. Next, the Airspeed Queen Wasp (1) on floats was seen in flight and the A.W. Whitleys were reviewed in Service.

From November 14 to 19 F/O A. E. Clouston and Mrs. Kirby-Green made a fine return flight to the Cape in the D.H. Comet *Burberry,* taking outward (45 hr. 2 min.), homeward (57 hr. 23 min.) and return (5 days 17 hr. 28 min.) records. The Hawker Hurricane appeared in production camouflage.

December has been important for the King's visit to the aircraft factories of Hawkers, Vickers, and Handley Page, and for the start of the five Saro Londons of No. 204 (G.R.) Squadron on their flight to Australia.

The annual demonstration of new French military and civil types was held before the French Air Minister and the Press at Villacoublay.

The twin-engined six-seater Percival monoplane (2), the Q.6 with D.H. Gipsy Six II engines and the Q.4 with Gipsy Major II engines, recently made its entry, following the little Deekay Knight.

PRIVATE FLYING

BIZARRE : The Gwinn Aircar is flown by its demonstrator, Lt. Cdr. Frank Hawks, over New York. Though its control system and flying characteristics are designed to make this quaint machine virtually foolproof, the urban paraphernalia below looks no less uninviting to the pilot of a single-engined machine.

Topics of the Day

Ornithology

IT was rather surprising to read in Sqn. Ldr. Buxton's sailplane paper that he did not see birds using what is known as dynamic soaring as a means of gaining height without the use of energy. He should certainly know better than I do, but from very casual observations of gulls I should have said that they use this method in conjunction with any straightforward up-currents which are available.

Therein lies the difference between the born soaring expert and one who has had to be trained to make the best of a bad job. The gull adjusts its speed and wing incidence not only to stay sometimes almost stalled in a purely local up-current, but also to make the most of wind-speed changes from second to second.

None of this has anything to do with the downwind turn controversy, in the arguments concerning which the wind speed must necessarily be taken as constant and the atmospheric "structure" as being perfectly smooth. Any apparent proofs of downwind effect necessarily involve special structure conditions about which we can only theorise—or else the prover is forgetting the obvious fact that the wind speed increases with height, and that a downwind turn into a faster layer causes a temporary drop in the machine's air speed.

Dynamics

THE ham-fisted power pilot's only experiences of dynamic effects are obtained during the last part of an approach on a gusty day. During the take-off a 100-odd h.p. of plain urge tends to smooth out the effects as far as physical sensations are concerned.

However, I recently noticed a particularly violent effect which may help to clarify the position in the minds of any who are unable to distinguish between fact and fancy—apart from reminding me, in particular, of the need for plenty of flying speed when approaching the ground in bumpy conditions.

The wind-speed on this day was about 15 m.p.h. at ground level, and the Met. people gave its speed at 2,000ft. as 35 m.p.h. The machine in question actually stalls at rather less than 45 m.p.h., but develops a pronounced sink at anything less than 50 m.p.h., unless this is checked by a good deal of elevator movement—the effect of which, of course, only lasts for a second or two as the speed drops to that of the true stall. The normal gliding speed is 60, and in these conditions I brought it in at 65 m.p.h.

After two circuits, which provided some interesting lessons in the matter of dealing with quickly changing hold-off effects, it seemed that a study of the A.S.I. might provide a clue to what was actually happening. When, on the third round, the machine was about a hundred feet up, I felt a pronounced bump, and the needle jumped momentarily to 85 m.p.h. The action of holding down the nose was instinctive, but, even so, the needle returned to 50 m.p.h. before climbing up again to the correct gliding speed. During the hold-off, the changes in A.S.I. reading were considerable and the business was quite lengthy, with a good deal of elevator correction, before the final and very sudden landing motion. (Interesting to find that one thinks of such matters as if some outside influence were providing the incentive for the movement of the stick. I can't explain in so many words quite why the stick does come back at a certain definite moment, which in nine cases out of ten is neither before nor after the critical split second.)

Obviously, when the A.S.I. reading first jumped, the machine had flown suddenly into an area in which the wind speed had increased, even when allowance had been made for position error and instrument inertia, something like 20 m.p.h. During this second or two the machine's ground speed had fallen to 35 m.p.h.; given time, the drop in ground speed would, of course, be equal to the increase in wind speed. Immediately afterwards the wind had dropped again to 15 m.p.h., leaving the machine with a ground speed of 35 m.p.h., and a consequent air speed of 50 m.p.h. The unexpectedly prolonged hold-off must have been caused by a temporary increase in wind speed or by a corrected momentary drop in this speed just before the hold-off, so that, in fact, the machine was suddenly invested with a supply of air speed to which it was not honestly entitled.

Logic

PROBABLY this series of explanations is as clear as mud to some people and too childishly obvious to be worth mentioning to other people. Well, I make no excuses. I have only to think of the extremely clever persons

Private Flying

who have been unable to follow logical reasoning about flies in railway carriages (or in the cabins of D.C.2s); about bullets fired by homicidal guards at innocent locomotive engineers who have elected to lean right out on perfectly straight stretches of permanent way; or about large chunks of a certain academically valuable yellow metal which are moved from place to place by cynical air transport operators.

Concerning the last, I am happy to agree that I should hate to be paid every month in cows, tons of coal, or acres of mangel-wurzels for the effort of writing this and other pages. At the same time, the cheque which I am glad to receive in place of such unmarketable products would have very limited use if my bank manager suddenly lost his supreme faith in the stability of the other bank on which my bit of printed paper is drawn.

People are so very queer. On many occasions I have been mildly sat upon for upholding the idea of the air brake as such, and with no aerofoil complications. More than one intelligent individual has complained bitterly that no such device could be arranged and used without moderate trim effects, and that it could not (therefore!) be used with any reasonable safety to stretch a glide near the ground.

Goodness me, the last-minute use of throttle on nearly every aeroplane causes a monumental change of trim, yet nobody would suggest that it is really dangerous to use motor, if necessary, during the last phase of the approach. It should not be difficult to design an air brake so that its trim-changing effect is almost negligible. Nor is there anything intrinsically dangerous about a very steep approach.

INDICATOR.

FROM the CLUBS and SCHOOLS

BORDER

THE Christmas holidays have disorganised flying for the main part although several members hired machines over the holidays. The club will be closed to-morrow and on New Year's Day.

MARSHALL'S

Flying times at Marshall's Flying School for the week ended December 26 totalled 21 hr. 50 min.

KARACHI

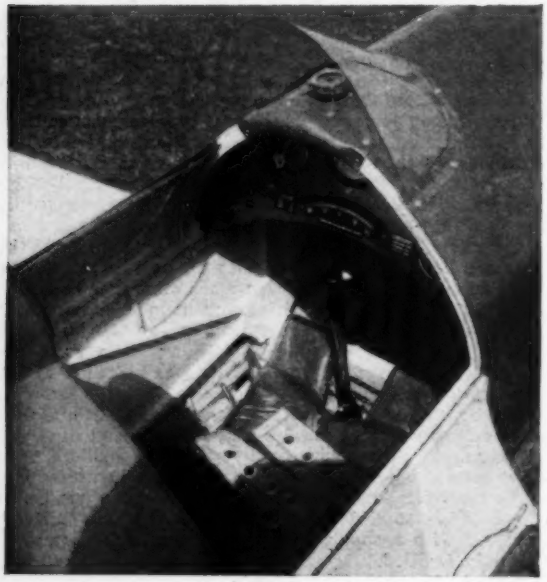
During November the Karachi Aero Club's hourage figures remained at a satisfactory level, a total of 218 hr. 55 min. being recorded during the period. Mr. D. J. Minwalla renewed his "A" licence.

HULL

The Hull Aero Club, in common with a number of others, found November a disappointing month in the matter of weather. However, a total of 25 hours' flying was put in and two more "A" licences obtained. The monthly dances will be continued until the Spring.

BENGAL

Although night flying instruction was temporarily postponed because the promised lighting equipment did not turn up, this should now be in full swing as a lighting set for one of the club machines has been sent by the agents of the firm concerned. During November a total of 60 hr. was flown, Mr. K. T. Maidment completed his Indian "A" tests and Capt. F. H. Rowan made his first solo since 1918.



DIRECTIVE CENTRE: Tidiness is the outstanding feature of the cockpit of the Chilton monoplane, some flying impressions of which are given on the next page. There are "doors" on each side and room for luggage below the headrest.

STRATHTAY

Recent snow blizzards have cut out all flying for ten days. The aerodrome is still covered with frozen snow and the prospect of flying are not good. The annual club ball will be held at the Salutation Hotel, Perth, on Friday, January 14.

RAND

The formation flying competition, held on November 28, was won by the Benoni Team, consisting of Messrs. A. G. Barratt, G. Roxburgh and W. Davis. The two new Miles Magisters have been delivered and should now be flying. Two members obtained their "A" licences and a total of 320 hr. 54 min. was flown during November.

JOHANNESBURG

A new Tiger Moth was brought into commission at the end of November, in which month the flying total was 650 hr. 40 min.—a record for the Johannesburg Club. Mrs. Peall obtained her "A" licence, and a dance, at which a hundred or so members and guests, including a party from the Rand Flying Club, turned up, was held on November 22.

NOTTINGHAM

Flying times have been much reduced lately owing to consistent bad weather and only 11 hours were logged between December 1 and 26. The annual children's party was held at the clubhouse on December 23 and was attended by 50 small guests. Father Christmas (Mr. T. Bullus) arrived by air to distribute toys. A New Year's Eve dance will be held at the clubhouse to-morrow. Mr. P. Bradley has purchased a Desoutter to replace his Leopard Moth.

MADRAS

Although the Madras aerodrome had a reputation for taking all the water in the world and still remaining dry, it has now been flooded by the north-east monsoon. Even so, flying has not been seriously handicapped. The cross-country and general knowledge competition for the Krishna Rao Trophy closed during the month. The winner was Master Parthasarathy, with Mr. J. D. Italia second and Mr. Rowson third. The winner qualified for his "A" licence two years ago, but as he was under 14 he was barred from flying solo. The annual landing competition for the Ames shield was held on November 28, four competitors tieing for the first place with half a mark consecutively between them. They were Messrs. Doraiswamy, Thirumalai, Ratnam, and Dr. Dyson. Four members who obtained "A" licences were Mrs. Kapadia, and Messrs. Shenoy, Aserappa, and Kearney.

Grounded?

MR. S. L. TURNER, who, during the last year or two, has done a great deal of useful work as a pilot on different newspaper and freight services, is now managing director of Shirley Motors, Croydon, and the new showrooms were recently opened in the customary manner. Until lately Mr. Turner has been flying for International Air Freight.

Manx Air Race Grant

A GRANT of £500 per annum is in future to be made by the Manx Government towards the promotion of the Isle of Man air race. This has been decided upon following the decision to abandon the Manx car race, and the grant which formerly went in aid of the car race has now become available for other purposes.

A committee of the Manx Government which has been considering the matter stated that the race cost £625 in 1936 and £788 in 1937, after allowing for the prize money generously donated by Mr. J. M. Cubbon. Their report continued: "We are unanimously of opinion that these races have a definite publicity value to the Island as a whole, and we recommend that the sum of £500 be allocated as a contribution towards the cost."

HIGH PERFORMANCE in MINIATURE

Some Comments on the Chilton Monoplane : Cruising at 100 m.p.h. on 30 b.h.p.

AFTER little more than half an hour's flying in a new type it may seem to be somewhat presumptious to make any comments on its handling and general qualities. On the other hand, initial impressions are those which really matter, since, after several hours' experience, one becomes so accustomed to a particular machine that it is difficult to remember and to analyse flying impressions as such. However, it was necessary to be content with a little plain circuit flying—which, at least, in visibility of the two-thousand-yards order, leaves one's mind free to consider a flying machine simply *as* a machine and not as a navigational implement.

Probably the first reaction of any person on being told of a machine which actually cruises at something rather better than 100 m.p.h. on less than 30 h.p. is that such a performance must somehow be paid for, either in a high landing speed, or in some vicious characteristic. In fact, the Chilton is perfectly normal in its habits and it lands, with the assistance of split flaps, at a good deal less than 40 m.p.h.

Its flying characteristics might be likened to those of any high-efficiency low-wing monoplane, built to a small scale. Furthermore, the machine has a rate of climb which is sufficiently good to remove any of those tree-scraping illusions from which one suffers in many of the ultra-lights; the maker's figure of 650 ft./min. is certainly not an optimistic invention. Provided that one has a properly instinctive realisation of the moment when a machine is ready to fly, the take-off, too, is quite short in distance, though moderately protracted in time. In fact, and according, as might be expected, to the purposes for which an owner requires such a machine, he can always, by a change of airscrew, obtain a superior take-off and climb at the expense of cruising speed.

Compromising

The machine which I flew was fitted with a compromise in airscrews, and, although it is never possible to guarantee indicated speeds, the machine reached its 100 m.p.h. quite quickly after levelling off, and comfortably held 95 m.p.h. on very little more than 3,000 r.p.m.—300 r.p.m. less than normal cruising. The best climbing speed appeared to be 60 m.p.h. The Ford engine is a comfortingly smooth means of propulsion, and at no time did the water temperature gauge reading exceed 85 deg. C.

In the matter of controls the Chilton is light and positive, and the machine, so to speak, demands that every turn should be a steep one. A couple of near-vertical rounds was my closest approach to aerobatics, if some flat side-slipping is discounted. This last manœuvre the machine does well and properly, though the speed cannot be kept below about 65 m.p.h. With three-position split flaps, however, the need for such height-losing tactics is not very obvious and the best way of approaching without a motor would be to play tunes on the flap lever between the first two notches, and to apply it fully just as the boundary has been crossed at 60 m.p.h. or so. With the flaps right down the gliding angle is steep enough to suit anyone—and with the flaps up it should be possible to cover a couple of counties downwind from 2,000ft. Until the true air-brake, independent of lift flaps, appears, all split-flap controls should obviously have a series of positions for different circumstances.

Whether or not I was being too cautious with an elevator control which I knew to be very sensitive at low speeds, or whether the view of the ground as the tail goes down is an awkward one until the pilot becomes accustomed to it, the fact must be admitted that my first landing was a thoroughly bad one. It was a wheeler for a start, a slight ridge or a gust sent me flying again, and the results were made even worse by the accidental use of the engine at the wrong moment. The useful width of the undercarriage and its four inches of travel possibly saved the day (i.e., one of the wing tips) and this minor experience proved that the Chilton would take at least something of the hammering which might be provided by a thoroughly raw novice. The next two landings were irreproachable, so I am ready to take all the blame.

THE CHILTON MONOPLANE

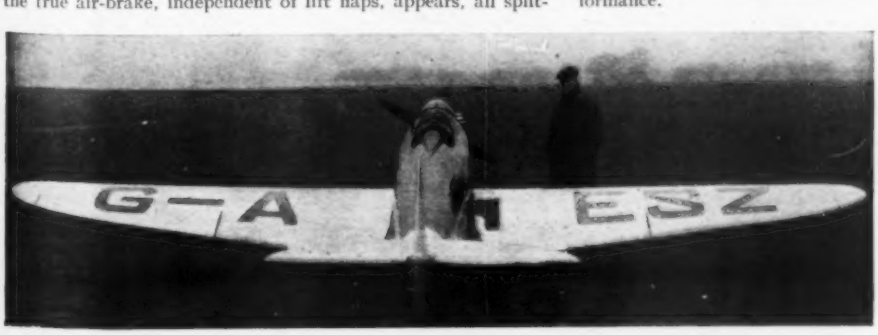
32 b.h.p. converted Ford engine with dual ignition.

Span	24 ft.
Length	18 ft.
Wing area	77 sq. ft.
Weight empty	398 lb.
All-up weight	640 lb. (max. 700 lb.)
Maximum speed	112 m.p.h.
Cruising speed	100 m.p.h.
Landing speed	35 m.p.h.
Rate of climb	650 ft./min.
Range	500 miles
Price	£315
Makers	Chilton Aircraft, Hungerford, Berks.

The accidental throttle motion was indirectly caused by a control system which works in the opposite direction to normal. This is a purely personal arrangement in a particular machine, and at no other moment did I object to the fact that the dashboard control must be pulled rather than pushed—the idea being to have the plunger out of the way when closed. The use of glider-type, or harmonium rudder pedals is another quite accidental feature which, consequently, may hardly be criticised, though paddling is thereby encouraged; full-leg rudder-bar movement certainly provides one with more definite control. Any other machine (a second one is coming along now) may have a standard throttle movement and a normal rudder-bar at the discretion of the purchaser. The next machine, too, will have the flap lever on the left side of the cockpit, where it may be moved without changing the stick hand.

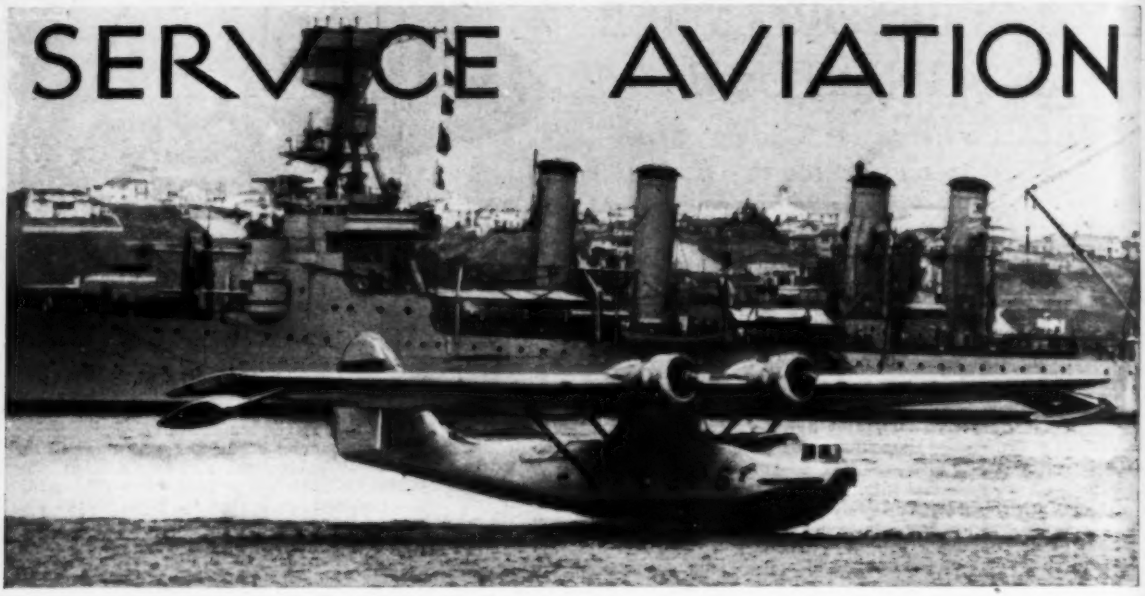
It is obviously impossible to deal adequately with the characteristics of an aeroplane in a few hundred words. Let the Chilton be temporarily explained as the useful result of a real endeavour to produce an economical, and properly finished machine with normal characteristics, yet an outstanding performance.

INDICATOR.



Some idea of the machine's small size and clean lines may be gathered from this photograph. The Hon. A. W. H. Dalrymple, co-conspirator with Mr. A. R. Ward, is standing by the nose. (*Flight* photographs.)

SERVICE AVIATION



A consolidated PBY flying boat of the U.S. Navy taking off from San Diego for the Panama Canal zone, 3,080 miles away. Thirteen machines made the trip non-stop.

Royal Air Force and Fleet Air Arm News : Official Announcements : Military Aviation Abroad

Gallantry in Wazaristan

THE King has been graciously pleased to approve of the following rewards for gallant and distinguished services rendered in connection with the operations in Wazaristan during the period January 17 to September 15:—

Distinguished Service Order.—Group Capt. Norman Howard Bottomley, C.I.E., A.F.C., and Wing Cdr. (now Group Capt.) Alan Lees, A.F.C.

Distinguished Flying Cross.—Sqn. Ldrs. Leonard de Ville Chisman and Ronald Hartley Carter, Flt. Lt. (now Sqn. Ldr.) Thomas Maxfield Abraham, and P/O. (now F/O.) Frederick Arthur Holmes.

Distinguished Flying Medal.—Sergt. (now Flt. Sergt.) Stanley Gordon Betty, Corpl. Stanley Herbert Mitchinson, and L.A/C. George John Springett.

M.B.E.

The King has approved the following award of the Medal of the Military Division of the Most Excellent Order of the British Empire for valuable services in the operations:

For Gallantry

Pilot Officer Gerald Charles Neil Close, Royal Air Force.

When an aircraft, laden with bombs, crashed and burst into flames on the Miranshah aerodrome, this officer, who was duty pilot on the aerodrome, hastened to the scene of the accident and, in spite of the explosion of a bomb and small arms ammunition, made persistent attempts to extinguish the flames and to rescue the crew until ordered to withdraw by a superior officer.

For Meritorious Service

Aircraftman 1st Class (now Leading Aircraftman) Gerald Scott Woodcock, Royal Air Force.

Eastern Inspection

MARSHAL of the Royal Air Force Sir Edward Ellington, Inspector-General of the R.A.F., left London last week to make a tour of inspection in the Middle and Far East. He will visit Egypt, India, Singapore and Hong-Kong.

Back from the Mediterranean

THE two squadrons of flying boats which were sent to Arzen, in Algeria, last September to take part in the anti-piracy patrol, have returned to Britain. The units are Nos. 209 and 210 (G.R.) Squadrons. The patrol was completely successful, and piratical attacks on ships ceased from the moment when it was instituted.

Flying Accident

THE Air Ministry regrets to announce the following accident:—A.P/O. Myles Leonard Birch and A.P/O. Christie Leslie Taylor lost their lives in an accident which occurred at Lypiatt, near Stroud, on December 21, to an aircraft of No. 3 Flying Training School, South Cerney, Cirencester, Gloucestershire. A.P/O. Birch was the pilot of the aircraft.

R.A.F.V.R. Cambridge Centre

A FURTHER centre of the R.A.F. Volunteer Reserve is now available for residents in Cambridge and surrounding districts. This has been established at an aerodrome at Cambridge, but it has been decided, in conjunction with the University authorities, that members of the University shall not be accepted for training at this centre, although they are eligible during vacations for training at other centres.

Electrical and Wireless School Inspection

AIR Marshal Sir Arthur Longmore, K.C.B., D.S.O., Commandant of the Imperial Defence College, inspected the Electrical and Wireless School, Cranwell, on December 21 on the occasion of passing out aircraft apprentices. The following are extracts from the report of the Commanding Officer:—

The strength of the Entry passing out is 97, and it consists of 84 wireless operator mechanics and 13 instrument makers. The average age of the Entry is 19 years 2 months, the oldest apprentice being 20 years and the youngest 18 years.

The Entry has undergone the prescribed course of study in educational subjects, i.e., Mathematics, Mechanics, Engineering Drawing, Empire History and Geography, and appreciation of Literature in the General Education School, and, according to trade, Electrical Science or the Principles of Physics applied to Instruments in the appropriate sub-schools.

Wireless Operator Mechanics

The results obtained by this entry in the Central Trade Test Board Examination are as follows:—L.A/C.s, nil; A/C.1.s, 20; A/C.2.s, 58. Six failed to qualify as Wireless Operator Mechanic and have been recommended by the Central Trade Test Board for reclassification to A/C.2 Wireless Operator, Group II.

Instrument Makers

The 13 pupils examined were classified as follows:—L.A/C.s, 2; A/C.1.s, 7; A/C.2.s, 4.

Cadetship

It is announced that a cadetship at the R.A.F. College, Cranwell, has been awarded to Sergt. Apprentice T. Thomas.

The Halton Inspection

THE following are extracts from the report of the Commandant of the R.A.F. Station, Halton, on the occasion of the passing-out inspection of aircraft apprentices on December 21. The inspection was carried out by Air Marshal Sir C. S. Burnett, K.C.B., C.B.E., D.S.O.

Of this entry 421 apprentices are passing into the Service. Of these, 10 have been classified as leading aircraftmen; 265 as aircraft-

men 1st Class; 125 as aircraftmen 2nd Class; 20 failed to qualify, and one was sick.

The first year's training of this entry was adversely affected by periods of isolation due to an outbreak of measles; their work in the Basic Section was thus curtailed. However, they made every effort to make up for lost time and how well they have done is shown in the results of the practical test portion of the C.T.T.B. Examination.

This Entry is the first to pass through the Service Training Section. This Section was formed in February, 1937, and ensures that apprentices work under conditions similar to those which exist in Squadrons. Unfortunately, the new workshops in which this Section is housed were not completed until quite recently. Future entries should receive full benefit from the new Section.

The health of this Entry has been well up to standard. An analysis of figures shows that the average time lost per aircraft apprentice through sickness was 109 hours. This is about normal.

Cadetships

The following have been selected for cadetships at the R.A.F. College, Cranwell:—Sergt. Apprentice C. Light, Sergt. Apprentice P. J. M. Nettleton, Corpl. Apprentice E. W. Padfield, Sergt. Apprentice C. Warren.

Viscount Wakefield Scholarship

Corpl. Apprentice Padfield.

School of Photography

THE undermentioned officers, having successfully completed the specialist photographic course at the School of Photography, South Farnborough, which terminated on October 30, are granted the symbol "Ph":—Flt. Lts. D. G. Keddie and P. B. B. Ogilvie; F/O. G. R. Lewis. The undermentioned officers also successfully completed the course:—F/O.s W. E. Bennett, Royal Canadian Air Force, and A. D. Charlton, Royal Australian Air Force.

Royal Air Force Gazette

Royal Air Force

General Duties Branch

Sqn. Ldr. F. R. Alford, M.C., is granted the acting rank of Wing Commander (paid) whilst serving as Royal Air Force Assistant Superintendent, Research Department, Woolwich (November 24); F/O. L. D. Dadswell is granted the acting rank of Flight Lieutenant (December 16); Sqn. Ldr. C. E. N. Guest, O.B.E., is seconded for duty with the British Military Mission, Egypt (December 2); Sqn. Ldr. N. S. Douglas is placed on the retired list on account of ill-health (December 16); Sqn. Ldr. W. B. Everton is placed on the retired list (December 16); Sqn. Ldr. H. A. L. Pattison is placed on the retired list at his own request (December 1).

Medical Branch

The following Flight Lieutenants are promoted to the rank of Squadron Leader (November 15): G. H. J. Williams, M.R.C.S., L.R.C.P.; J. F. McGovern, M.B., M.Ch.

Royal Air Force Reserve

Reserve of Air Force Officers
General Duties Branch

The following are granted commissions as Flight Lieutenants in Class C with effect from the dates stated:—Flt. Lt. A. H. Dalton (November 1); Capt. W. Coker, D.F.C. (November 8).

Flt. Lt. A. H. Coslett-Derby relinquishes his commission on completion of service (December 1).

Equipment Branch

Flt. Lt. L. N. Sargent (R.A.F. ret.) is granted a commission in that rank in Class C (September 1).

Royal Air Force Volunteer Reserve

Medical Branch

G. G. Stewart, M.R.C.S., L.R.C.P., D.P.H., is granted a commission as Flight Lieutenant with effect from December 21.

Auxiliary Air Force

General Duties Branch

No. 605 (COUNTY OF WARWICK) (BOMBER) SQUADRON.—Viscount Bearsted, M.C., relinquishes his appointment as Honorary Air Commodore (December 15).

Owing to the greatly increased length of these lists as a result of R.A.F. expansion, ranks are confined to those of Flight Lieutenant and above.

FOREIGN SERVICE NEWS

D.H.s in Uruguay

NOVEMBER 20 was the 21st anniversary of the formation of Uruguayan Military Aviation and was marked by the formal opening of the aerodrome at Pando recently acquired from Air France.

The inevitable flying display included some nice formation work by eighteen D.H. Tiger Moths and some clean aerobatics. A Rapide ambulance was also flown. Other types were eight old Potez and six new Bredas. Half a dozen Wacos for advanced training had not arrived in time.

Turkish Defence

THE Air Defence Union of Turkey has received contributions of something over £T2,000,000 during the last six months. £T600,000 came from the Aeroplane Lottery, one of the few lotteries allowed in Turkey. During the same period the union has presented 26 new military aircraft to the army.

The union is planning the production of parachutes from locally grown silk. If the army will purchase these, the union will acquire a licence from the Irvin Company and manufacture the 'chutes itself.

The French Estimates

AMOUNTING to about ten million pounds, the French Air Estimates have been passed by the Chamber of Deputies. They represent an increase of 5½ million pounds as compared with the 1937 figures. Replying to fierce condemnation of French equipment and organisation, M. Pierre Cot, the Air Minister, said that France could boast that her aircraft were superior to all others. The creation of an aerial arm for the artillery was under consideration.

The Australian N.A.16's

THE new North American NA 16 two-seater general purpose machines under construction for the Australian Government by the Commonwealth Aircraft Corporation will incorporate a number of improvements over the original model (used by the U.S. Army Air Corps for advanced training), as, for instance, a 640-h.p. Wasp instead of a 550-h.p. model. The maximum speed will be about 220 m.p.h. The company, incidentally, has acquired the right to build the Gipsy Major II in Australia. Aero engine construction will be directed by the American expert P. W. Schipper.

A Four-Engined Consolidated

KNOWN in U.S. Naval parlance as the XPB2Y-1, a new four-engined patrol bomber has been completed by the American Consolidated concern whose twin-engined monoplane boats are among the most successful long-range military aircraft in the air to-day. The new boat has beaching gear which may be stowed in racks in the hull, sleeping and living quarters, galley, clothes lockers, heating arrangements, soundproofing, a complete telephone system, and a workshop. As in the current Consolidated twin-engined boats, the floats are retractable to form the wing tips. When lowered the floats and their supporting gear make effective air brakes.

AN AMERICAN "WET": The new Curtiss P-37 single-seater pursuit monoplane with 1,000 h.p. Allison liquid-cooled engine, the first American machine of its type to be fitted with anything but a radial for some years. It seems that the exhaust-driven blower is housed more carefully than in previous installations of the Allison.

THE INDUSTRY

Mollarts Celebrate

IN 1930, in the midst of the depression, the Mollart Engineering Company was founded with a capital of £250. To-day there is a £50,000 concern, with a fine new works on the Kingston By-pass, at Surbiton.

This story of the firm's progress was told by Mr. A. J. Mollart, the managing director, at the annual works Christmas luncheon, held at the Ace of Spades last Friday. Mr. Mollart related how the firm's reputation had been largely built up on the "M.E." patented universal ball-joint; he was proud to claim that there were not many British civil or military aircraft in which these joints did not figure, and they were being used in the Short Empire boats and the D.H. Albatross.

The manufacture of these joints, however, is only one side of the business; the other is precision engineering, with particular emphasis on gauge and jig manufacture. Mollarts have an Air-Ministry-approved gauge test-house, said to be the only one in Southern England.

Cdr. Holbrook, V.C., R.N., of submarine and Dardanelles fame, was among the guests at the luncheon.

Fairey Progress

THAT the Fairey Aviation Company was now reaping the benefit of having four plants in full production was pointed out by Mr. C. R. Fairey (chairman) at the annual general meeting last week. The year might have been described as the first normal one following two lean years of preparation and initiation of new designs. He reported a profit of £248,178 up to September 30.

The largest of the four factories, the Stockport one, strategically situated on the western side of the Pennines, had assisted trade recovery in that district by the employment of some thousands of men. Mr. Fairey said that much of the credit for the successful inauguration of that works went to Major T. M. Barlow and his staff.

The Hayes works had experienced a year of continuous output, and preparations were already in hand for a new type of aircraft. The airscrew factory at Hayes, which was considerably extended last year, was ready to produce new types of airscrew which were at present the subject of experimental work. Avions Fairey, in Belgium, had had a very good year, and, lastly, co-operation with the Austin Company, who were making Fairey machines at their "Shadow" factory, was proceeding excellently.

It had been decided to erect a new research department, including a large and most up-to-date wind tunnel and new chemical and physical laboratories. This would be ready next summer.

NEW COMPANIES

In the notes below, for reasons of space, the "objects" of new companies are usually somewhat abbreviated.

NORTH WALES AIRPORT, LTD.—Private company, registered December 8 Capital, £100 in 100 shares of £1 each. Objects: To operate such licence as may be granted from time to time by the Air Ministry; and to carry on business as purchasers and vendors of aircraft, aerodrome and air base proprietors, flying instructors, etc. The directors are: Herbert Lowe, Tudor House, Mochdre, Colwyn Bay; and Harry Lowe.

MECHANISM LTD.—Private company, registered December 6. Capital, £1,500 in 1,500 shares of £1 each. Objects: To acquire the business of a scientific instrument maker and aeronautical and precision engineer heretofore carried on by Capt. Harold C. Peirce, trading as "Mechanism," at 6a, George Street, Croydon. The directors are: Capt. Harold C. Peirce and Henry Darrell.

BEDFORD SCHOOL OF FLYING LTD.—Private company, registered December 1. Capital, £1,000 in 10,000 shares of 2s. each. Objects: To teach aerial navigation in all its forms; to establish and maintain a club, etc. The permanent directors are:—Dorothy O. Summers, 26, Tilehurst St., Hitchin, secretary; Leslie C. Hilditch, "Scylla," Pirton Road, Hitchin, flying instructor.

CONRAYS LTD.—Private company, registered December 4. Capital, £30,000 in 30,000 shares of £1 each. Objects: To carry on the business of manufacturers of and dealers in anti-dazzle devices, appliances and scientific instruments for all vehicles, including land, marine and aircraft, also for aerodromes, film studios, and street and allied lighting, etc. The directors are: Lt. Col. Arthur H. C. Sutherland, 36, Upper Brook Street, London, W.1.; Major Wilmont R. B. Peel.

INCREASE OF CAPITAL

LISSEN AIRCRAFT & PRECISION ENGINEERING CO. LTD., Priory Works, Priory Yard, Belsize Road, London, N.W.6.—The nominal capital has been increased by the addition of £1,700 beyond the registered capital of £5,800.

UNIVERSAL AIRCRAFT SERVICES LTD. (6, Broad Street Place, London, E.C.2).—The nominal capital has been increased by the addition of £500 in £1 "B" ordinary shares beyond the registered capital of £2,500.

HAWKER SIDDELEY AIRCRAFT COMPANY LTD. (3, St. James's Square, London S.W.1).—The nominal capital has been increased by the addition of £2,000,000 beyond the registered capital of £4,000,000. The additional capital is divided into 2,000,000 5 per cent. redeemable cumulative preference shares of £1 each.

AIRWORK GENERALTRADING COMPANY LTD. (Heston Airport, Hounslow, Mddx.).—The nominal capital has been increased by the addition of £19,900 in £1 ordinary shares beyond the registered capital of £100.

NORTH EASTERN AIRWAYS LTD. (Airport of London, Croydon, Surrey).—The nominal capital has been increased by the addition of £30,000 in £1 ordinary shares beyond the registered capital of £20,000.

HANDLEY PAGE, LTD. (Cricklewood, London, N.W.2). The nominal capital has been increased by the addition of £124,465 beyond the registered capital of £323,609. The additional capital is divided into 497,860 ordinary shares of 5s. The new shares have since been converted into £124,465 ordinary stock.

AERONAUTICAL PATENT SPECIFICATIONS

(The numbers in brackets are those under which the Specifications will be printed and abridged, etc.):

(*Published December* 2, 1937.)

14428. PLESSEY CO., LTD., and BAILEY, C. E. G.: Radio direction-finding equipments (474,690).
7745. HULEY, P.: Aeroplanes (474,659).

(*Published December* 9, 1937.)

3767. KRUESI, G. G.: Radio compasses and direction-finders (474,972).
7020. SJOSTRAND, H. E.: Radio-navigating means for locating the position of a movable body (475,027).
13165. SHORT BROS. (ROCHESTER AND BEDFORD) LTD., and PARKS, A. G.: Means for operating control gills of engine cowlings (474,912).
13207 STEVENS, A. H. (Sperry Gyroscope Co., Inc.): Gyroscopic flight indicators for aircraft (475,097).
13357. PERRY, R.: Control mechanism for amphibian aircraft (475,057).
13456. GRAY, W. E.: Aeroplane wing flaps (475,164).
13514. CHANCE BROS. & CO., LTD., and HARRIS, R. C.: Searchlights and like apparatus (475,108).
13659. SOC. FRANCAISE HISPANO SUIZA: Resilient suspensions for aircraft engines (475,124).
31238. VOICIECHAUSKIS, B.: Safety device for aircraft (474,862).
3850. DORNIER-METALLBAUTEN GES: Power plant, comprising a plurality of internal-combustion engines for motor vehicles, more particularly aircraft (474,872).
13363. ELEKTRONMETALL, GES: Undercarriages for aircraft (475,019).
19273. JUNKERS FLUGZEUG-UND-MOTORENWERKE AKT.-GES: Pistons for internal combustion engines (474,969).
25398. STEVENS, A. H. (Sperry Gyroscope Co., Inc.): Gyroscope flight indicators for aircraft (475,152).
29498. KRUESI, G. G.: Radio compasses and direction-finders (475,090).

(*Published December* 16, 1937.)

10980. BARAHART, G. E.: Aeroplane construction (475,493).
13966. GRAY, W. E.: Aeroplane wing flaps (475,500).
14162. SUPERMARINE AVIATION WORKS (VICKERS) LTD., MITCHELL, R. J., and BLACK, A.: Retractable undercarriages for aircraft (475,504).
14512. DODSON, E.: Cowling flaps for aircraft engines (475,525).
17858. ASKANIA-WERKE AKT.-GES. VORM. CENTRALWERKSTATT DESSAU UND C. BAMBERG, FRIEDENAU: Direction-indicating means for use on land, air, or water craft (475,372).
20102. ASKANIA-WERKE AKT.-GES. VORM. CENTRALWERKSTATT DESSAU UND C. BAMBERG, FRIEDENAU: Mounting of gyroscopic instruments in aircraft (475,375).
18953. FAIREY AVIATION CO., LTD., and BOLTON, F.: Aircraft having folding wings (475,433).
26275. GAVARDIE, P. H. E. DE: Gun turrets, particularly for aircraft (475,377).
30281. FAIREY AVIATION CO., LTD., and HILTON, L. M.: Aircraft having folding wings (475,218).
31997. SAULNIER, R.: Landing-gear for aircraft (475,222).
32043. ELLINGHAUSEN, H.: Fastenings for wooden blades in the blade sockets of air propellers, more particularly adjustable propellers (475,306).
4880. SHORT BROS. (ROCHESTER AND BEDFORD), LTD., and SLADE, F. H.: Apparatus for separating rain from air in ventilating systems for aircraft (475,388).
6323. SOC. ANON. FABRICA ITALIANA ELICHE PER AVIAZIONE: Arrangement for operating the blades of variable-pitch propeller or tractor screws (475,240).
6623. AEROSTATICA AVORIO SOC. IN ACCOMANDITA SEMPLICE: Suspension of parachutes (475,241).
8359. ALKAN, R.: Directional gyroscopes (475,321).
10588. POTEZ, H. C. A.: Flap device for cowlings of air-cooled aviation and other engines (475,250).
14169. JUNKERS FLUGZEUG-UND-MOTORENWERKE AKT.-GES.: Charging of internal-combustion engines for aircraft (475,329).
20843. ARMSTRONG SIDDELEY MOTORS, LTD., FELL, L. F. R., TOWNS, H. L., and CUTLER, G. M.: Control of gearing for driving superchargers on aircraft engines (475,341).

(*Published December* 23, 1937.)

1530. COWEY, L. E., and EUGSTER, E. J. P.: Aeroplane landing gear (475,785).
5788. BRISTOL AEROPLANE CO., LTD., WHITEHEAD, F. W., and GOODBY, W. T.: Manufacture of sleeve valves for internal combustion engines, or like cylindrical objects (475,864).
14611. PIONEER INSTRUMENT CO., INC.; Indicating instruments for aircraft (475,656).
14991. GLASER, M. A.: Flying-machines (475,587).
21498. WERKZEUGMASCHINENFABRIK OERLIKON: Percussion fuses for projectiles (475,596).
22761. ASHLOCK, E. H.: Navigation instrument (475,918).
32394. BRONZAVIA SOC. ANON: Vacuum or compressed-air systems for aircraft apparatus (475,699).
9901. TELEFUNKEN GES. FUR DRAHTLOSE TELEGRAPHIE: Navigation-aiding radio systems for assisting blind landing of aircraft (475,853).

(*Published December* 30, 1937.)

15486. DEKKER, A. J.: Screw-propeller devices (476,226).
15890. VICKERS (AVIATION) LTD., and ELLIS, D. L.: Means for controlling aircraft (476,258).
26402. FLYNT, L. W. G.: Streamlined tie-rods for aircraft and like members, and method of making the same (476,133.)
27799. HEINE, H. (trading as HEINE MOBELFABRIK PROPELLERWERK, H. (Firm of): Wooden airscrews (476,270).
5030. STANDARD TELEPHONES AND CABLES, LTD.: Radio beacon system (476,215).
6476. LORENZ AKT.-GES., C.: Power lines for wireless antennæ (476,279).
7464. SIEMENS APPARATE UND MASCHINEN GES.: Gyroscopes having direct-current motor-drive (476,013).
16479. ASKANIA-WERKE AKT.-GES. VORM. CENTRALWERKSTATT DESSAU UND C. BAMBERG, FRIEDENAU: Gyroscopes (476,033).
16480. ASKANIA-WERKE AKT.-GES. VORM. CENTRALWERKSTATT DESSAU UND C. BAMBERG, FRIEDENAU: Gyroscopes (476,034).
17226. KRAFFT, E., WEICHARDT, R., FREISTADT, W., and HICKE, J.: Apparatus for manipulating aircraft landing-sails (476,288).
21267. DAIMLER-BENZ AKT.-GES.: Ignition timing-controls for internal-combustion engines (476,292).

December 30, 1937. Supplement to FLIGHT 652 a

The AIRCRAFT ENGINEER

"FLIGHT" ENGINEERING SECTION

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WING LOADING*

Its Effect on the Design of Modern Aircraft, with Particular Reference to the Take-off Problem.

By H. F. VESSEY, B.Sc., A.F.R.Ae.S.

(*Continued from page 33*)

Take-off

THE case of normal take-off will first be treated and then the several methods of assisted take-off which may be used will be discussed.

The distance to take-off is approximately given by the equation (Appendix II)

$$\text{Run to take-off} = V^2 / \left\{ 2g(T_m/W - \mu) \right\} \quad . \quad . \quad . \quad (6)$$

where V is the take-off speed ft. per second; T_m is the mean take-off thrust corrected for slipstream drag and is approximately the corrected thrust at 0.7 take-off speed; W is the all-up weight at take-off; and μ is the effective coefficient of friction.

This equation is reasonably correct if T_m/W is appreciably larger than μ, but gives an optimistic answer when the two terms approach each other in value, or, in other words, when the take-off run is long. To show the effect of wing loading we may rewrite the equation as

$$\text{Run to take-off} = (w/C_L) / \left\{ g\rho(T_m/W - \mu) \right\} \quad . \quad . \quad . \quad (7)$$

from which it will be seen that the run depends directly upon w, thus showing the difficulties we are faced with in increasing wing loading above present values.

If we attempt to maintain present take-off distances for any increase in wing loading there are three quantities which we may alter:—

(i) The take-off lift coefficient;
(ii) The ratio thrust over weight which may be modified by increasing the airscrew thrust; or
(iii) The coefficient of friction.

(i) *Take-off Lift Coefficient.*—The maximum lift coefficient can now be considerably increased by the use of flaps, and it has also been established that the take-off run can be reduced by their use if the thrust to weight ratio is high enough to mask the effect of the increase in drag that they cause. It has been recognised for some time that the slipstream from a wing or even nose engine increases the lift of a wing by virtue of the extra velocity, and this effect can be increased to an astonishing extent by the use of flaps. It is now possible to obtain a lift coefficient C_L at take-off of 2.4 for a twin-engined monoplane with low drag flaps, and by increasing the number of airscrews or their diameter or by decreasing the total wing area so that a larger proportion is covered by slipstream a considerable further increase should be possible. To obtain the maximum increase without inordinate drag it will be necessary to use flaps of low drag characteristics, although it has been found that quite a substantial decrease in take-off run can be obtained with the simple split flap if the thrust over weight ratio is high. Several of the low drag type of flap are now available, but most of them suffer from the disadvantage that they do not provide enough drag for the landing condition. What is needed is a low drag flap giving a substantial increase in lift coefficient at take-off, and which in addition can provide a high lift and high drag for landing. In the landing condition the amount of drag should preferably be under the control of the pilot, the lift being constant over a large range in drag so that the gliding path may be varied at will with but little change in speed. In several recent designs the take-off has had to be penalised by the fitting of high drag flaps required to meet the landing condition and there is real need of a dual purpose flap of the type described.

Messrs. Goodman-Crouch and Bolas have in America carried the idea of providing slipstream lift to the limit by using large airscrews and covering almost the whole of the wing with slipstream. In addition, the thrust axis is tilted downwards so that the effective angle of incidence of the wing is increased.

The use of slipstream on flaps considerably increases the effective lift coefficient at take-off and hence reduces the take-off distance, but unfortunately the distance from take-off to clearing a barrier is generally increased. Due to the lower take-off speed the time taken to accelerate to climbing speed will be increased, and even if the pilot attempts to climb immediately after the take-off without accelerating the speed will be so far removed from best climbing speed that the rate of climb will be low. In spite of this increase, however, the distance from rest to clearing the barrier is in most cases considerably reduced by the use of slipstream on low drag flaps. One disadvantage of attempting to obtain as large a wing area as

* Abstract of Paper read before the R.Ae.S. on November 18, 1937.

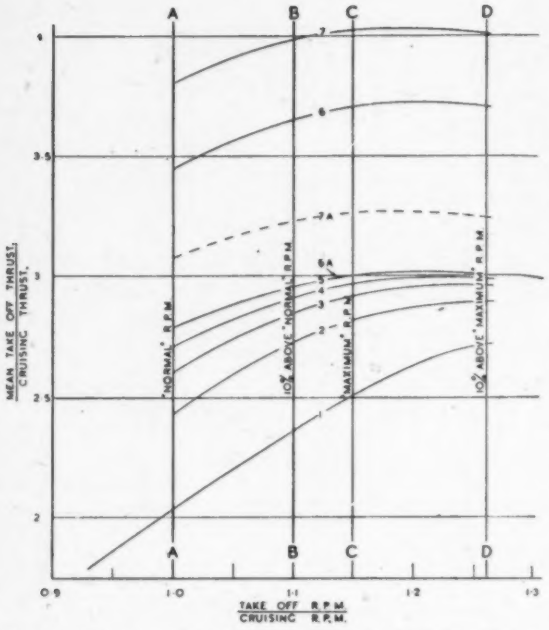


Fig. 5.—Mean take-off thrust. Effect of airscrew-engine conditions for typical take-off power curve.

possible in the slipstream is that the drag at high speeds will be increased due to the extra velocity and turbulence of the slipstream.

(ii) *Take-off Thrust.*—The use of variable-pitch airscrews in conjunction with engines allowing high power and r.p.m. at take-off gives a considerable increase in take-off thrust, particularly with fast aircraft fitted with highly supercharged engines where the coarse-pitch airscrew is normally stalled at low speeds and therefore gives a low thrust. Two-pitch airscrews show a considerable improvement over the fixed-pitch airscrew, but are limited in their use as a single pitch cannot be used to give best take-off and best climb.

The use of an infinitely variable pitch or constant-speed airscrew removes this difficulty, for the pitch may be reset to allow maximum permissible r.p.m. at any forward speed. The constant-speed airscrew is desirable as the pilot need only set the control unit to the desired r.p.m. and the pitch change required will be obtained automatically. Thus best climb and best take-off may both be obtained.

An increase in take-off thrust may be obtained by designing the airscrew in its high-pitch position for a speed lower than the normal cruising speed. This will be done by increasing the diameter or the blade width and decreasing the pitch for the cruising condition. A large increase in take-off thrust may then be obtained at the expense of a small decrease in airscrew efficiency at cruising speed. The engine designer can also be of assistance by allowing higher engine speeds, and possibly higher engine powers, at take-off. Of the two in general speed is the more important. To show the effect of the main variables, Figs. 5 and 6 have been prepared from the best available data. The take-off thrust is given in terms of the thrust in the designed cruising condition and is the thrust at a speed of 0.7 take-off speed, which for a simple analysis may be considered as the mean take-off thrust. The difference between the various conditions would have been greater at lower air speeds, and particularly in the static condition, but these cases do not so well show the general effect on the take-off. The r.p.m. and b.h.p. are given in terms of the r.p.m. and b.h.p. in the cruising condition, which is assumed to be at the "normal" or "international" r.p.m. of the engine. The power in this cruising condition will be approximately two-thirds of the maximum power for level flight. Fig. 5 shows the effect of the design conditions for the airscrew and of the allowable r.p.m. for a representative take-off power curve. Curves 1-5 refer to different design condition of an airscrew suitable for flight at 250 m.p.h. at 5,000ft., while curves 6 and 7 refer to airscrews designed for the same aircraft with a similar engine supercharged to 25,000ft., which with the same power will give a speed of 300 m.p.h. The line A-A defines normal r.p.m., which before the general use of V.P. airscrews would be the maximum allowable r.p.m. at take-off, while B-B defines the r.p.m. at 10 per cent. above "normal," which is now the most usual rating for take-off with variable-pitch airscrews. Line C-C is at "maximum r.p.m. in level flight," and D-D at 10 per cent. above "maximum r.p.m. in level flight," these two conditions being concessions which may be granted by engine manufacturers in the future if the advantages to be gained are sufficient to warrant the allowance of the higher engine loads. Already some American engines are rated for take-off at r.p.m. closely approaching the 10 per cent. over "maximum r.p.m. in level flight."

Curve 1 shows the thrust ratio for an airscrew designed to give optimum efficiency at the cruising condition. The thrust given by a fixed-pitch airscrew is shown at the left-hand end of the curve, and it will be seen that a 32 per cent. increase in thrust may be obtained with a V.P. airscrew with the usual engine condition of 10 per cent. above normal r.p.m., while a 40 per cent. increase is given by allowing "maximum r.p.m. in level flight" and 52 per cent. increase by allowing 10 per cent. over "maximum r.p.m. in level flight." The airscrew of curve 1, as explained before, is designed for maximum efficiency at the cruising condition, and for a reasonable blade width the diameter is lower than could be allowed from the point of view of tip speed loss and airscrew noise when cruising. Curves 2, 3, 4 and 5 show the take-off thrust of similar airscrews of increasing diameter but the same solidity, the last one of which gives a helical tip speed of 800ft. per second at cruising, which is arbitrarily assumed to be the upper limit.

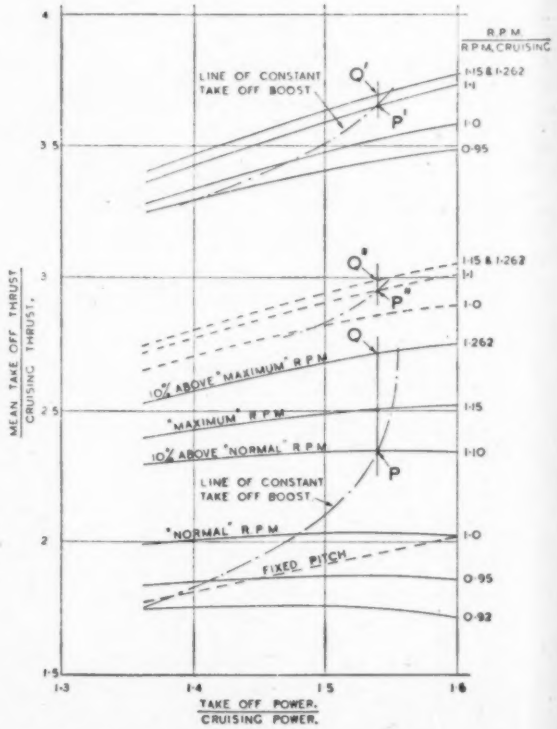


Fig. 6.—Mean take-off thrust. Effect of power and r.p.m.

Curve 2 is for an airscrew of slightly larger diameter than 1, which gives a loss of half per cent. in efficiency when cruising, and the increase in take-off thrust is astonishing, particularly when it is realised that the loss in cruising speed will be only about one-half m.p.h. Curves 3, 4 and 5 are for similar airscrews of increasing diameter, giving losses in efficiency at cruising of 1, 2 and 3 per cent. respectively. The last of these airscrews will give a loss in cruising speed of about 2½ m.p.h. It will be noted that these curves are closing up and that little take-off thrust is gained by increasing the loss in cruising efficiency from 2 to 3 per cent. The curves are also becoming flatter, and show less increase in thrust from increase in engine r.p.m., both of these results being caused by the increased tip speed effect on the higher-diameter airscrews.

"Stratosphere Flight"

Curve 6 gives the thrust ratio for an airscrew designed for maximum efficiency at a speed of 300 m.p.h. at 25,000ft., this case being included to show the effect of "stratosphere flight." Curve 7 is for an airscrew designed with a 2 per cent. loss in efficiency at this height and cruising speed. For this airscrew it has been assumed that the diameter cannot be increased because of noise and tip speed loss when cruising or at maximum speed. To lower the design speed it has therefore been necessary to increase the blade width. The effect is similar to an increase in diameter, and the result is a considerable increase in take-off thrust. In general, an increase in diameter is more effective in increasing take-off thrust than increase in blade width, but it ceases to be of value when the tip speeds approach the velocity of sound. Curves 6 and 7 give a considerably greater thrust ratio than curves 1-5. To a certain extent this is misleading, as the design thrust in the former cases is low due to the higher cruising speed. Curves 6 (a) and 7 (a) have therefore been drawn to indicate the thrusts in cases 6 and 7 relative to the design condition of 250 m.p.h. at 5,000ft. Curves 6 (a), 7 (a) and 1-5 are then strictly comparable, and give a relative indication of the actual take-off thrusts available. Curves 5 and 6 (a) coincide, and an airscrew which at 250 m.p.h. at 5,000ft. gives a loss in maximum efficiency of 3 per cent. works at optimum efficiency at 300 m.p.h. at 25,000ft., although the pitch angles in the two cases will be different. For a loss in cruising efficiency of 2 per cent. an airscrew designed for 25,000ft. gives about 10 per cent. greater actual take-off thrust than an airscrew designed for the same loss in efficiency at 5,000ft. The assumptions made here that the same power is available at 25,000ft. as at 5,000ft. and that the take-off powers in the two cases will be the same may be questioned, but it is thought that with multi-stage blowers and inter-coolers this condition will be approximated.

Designing for Altitude

In view of the proposals for high-altitude flight these results are encouraging, as the conclusion must be that an airscrew designed for high-altitude flight gives a better take-off performance than one designed for use at normal altitudes, provided that the same allowable r.p.m. and b.h.p. at take-off are given by the two engines. The reason for this is that the higher speed and lower density at altitude necessitates a larger diameter or greater solidity, both of which tend to increase take-off thrust. In practice difficulty may arise due to the considerably larger pitch change required in the case of the airscrew for the high-altitude aircraft, but with most types of variable-pitch airscrew this greater pitch change could be provided, although in some cases a slight addition in weight would be caused.

Fig. 6 has been plotted to show the effect of horse-power and engine speed on the thrust ratio for the two airscrews 1 and 6—that is, the airscrews designed for maximum efficiency for the two cases of flight at 250 m.p.h. at 5,000ft. and 300 m.p.h. at 25,000ft. While Fig. 5 indicates the thrust obtained with a normal take-off power curve, the engine operating at constant boost (Fig. 6 is more general, as no fixed relation between b.h.p. and r.p.m. is assumed) so that the change in thrust for increase of b.h.p. at constant r.p.m., or for increase in r.p.m. at constant power, may be obtained. An examination of these curves shows that at low r.p.m. an increase in power (given by increased boost) gives little or no increase in thrust. In fact, after a very slight initial rise, there is actually a drop in thrust. As the r.p.m. is increased, the effect of power becomes greater, but even at 10 per cent. above "maximum permissible r.p.m. in level flight" the effect is comparatively small. On the other hand, increase in r.p.m. at constant power is a very powerful factor in increasing thrust. The chain dotted line drawn across the curves defines the conditions at which normal take-off boost is obtained, and the points on this curve therefore correspond with those in Fig. 5. Points to the left of this curve give engine conditions where the boost is lower than the maximum allowable, and those to the right where it is higher. Thus, there is the possibility of obtaining a considerable increase in thrust by allowing an increase in engine speed at constant power (or even reduced power) by a reduction in take-off boost. This will, of course, mean that the airscrew pitch must be reduced so that its rate of rotation will increase, the pitch change being such that the same (or less) power is absorbed. For example, point P shows the usual limitation of 10 per cent. above normal r.p.m. at take-off boost. By allowing the r.p.m. to increase to 10 per cent. above "maximum r.p.m." at the same power but reduced boost, the point Q is reached where the thrust is increased about 15 per cent., while even at a lower power but the same r.p.m. the increase in airscrew speed gives almost as great an increase in thrust.

Two-speed Gears

If it is not possible to increase the engine r.p.m. to this extent because of inertia loads, the alternative is to fit a two-speed gear so that the engine r.p.m. may remain constant while airscrew r.p.m. is increased as much as is desirable. In this case the point Q will be obtained by a gear 1.17 times the normal cruising gear.

The effect of increased power with a fixed-pitch airscrew is shown by a dotted line crossing the lines of constant r.p.m. In this case an appreciable increase in thrust is given by a rise in power due to the fact that the engine speed is also increased by the higher torque.

The upper series of curves referring to the high-altitude airscrew are of similar form, but the change in thrust from an increase in airscrew speed is less, this being due to the tip speed losses caused by the greater diameter. The points P' and Q' have the same significance as before, and in this case it will be seen that little increase in thrust is obtained by increase of r.p.m. at constant power or by the use of a second gear. As explained before, this high-altitude airscrew may be considered as the equivalent of an airscrew designed for cruising at 5,000ft. with a 3 per cent. loss in efficiency. The dotted curves show the take-off thrust of this airscrew relative to the design condition at 5,000ft., and the inference to be drawn therefore is that the device of using a larger diameter than that giving maximum cruising efficiency gives a thrust greater than that obtainable by the use of a two-speed gear with the normal airscrew, and that the use of gears with the large-diameter airscrew shows no appreciable advantage. The actual value of the thrusts obtained by these two methods will, of course, vary with the engine/airscrew conditions, the two-speed gear being of greater value when the tip speed of the increased diameter airscrew is low. An increase in cruising speed will also cause the two-speed gear to be of greater value due to the smaller diameter of the airscrew appropriate to the higher cruising speed.

(iii) *Variation of Coefficient of Friction.*—The term μ in the take-off equation includes bearing friction and the rolling friction of the tyres. There are therefore three main variables affecting the coefficient of friction—the bearing friction, tyre conditions and the condition of the ground surface. A recent N.A.C.A.* report gives the results of

* N.A.C.A. Report No. 583. "The Rolling Friction of several Aeroplane Wheels and Tires," by J. W. Wetmore.

some tests on this subject. The general conclusions of the report are that on a concrete runway the rolling coefficients vary from 0.009 to 0.035, on firm turf from 0.023 to 0.054, and for soft turf from 0.064 to 0.077. The effect of plain bearings in place of roller bearings was to increase the rolling coefficient on concrete by about 0.007, a very considerable increase on the lower values obtained.

On concrete and firm turf the low and medium pressure tyres gave approximately the same value of rolling coefficient, while those for the extra low pressure tyres were considerably higher. On soft turf only the medium pressure tyres were tested. It is stated in the report that the tests were done at varying speeds, but, unfortunately, the effect of speed on the coefficients is not quoted. It is to be expected that on any but a smooth surface the effective rolling coefficient will increase appreciably with speed, due to the extra energy loss in the oleo leg and tyre caused by the unevenness of the surface. It is probable, however, that the figures quoted above can be assumed to be the mean figures acting during a normal take-off run.

From other sources the rolling coefficient of a metal wheel on a rail is about 0.01, this being a comparatively high figure due to the friction of the flange, while the coefficient of friction of an aeroplane wheel on a smooth surface, such as the deck of a ship, is approximately 0.02.

Flying Boat Problems

Flying boats taking off from water present a problem in themselves and considerable work has been done in developing hull forms to give the lowest water and air drag, two conditions which in general are conflicting ones. As a very rough approximation used only to bring the flying boats into this general treatment, the water drag may be considered to be given by an effective coefficient of friction (defined as water drag/load on water), a mean value for modern hulls being 0.22. This coefficient will vary considerably with hull form and all-up weight and will give an optimistic value for the take-off run if the thrust/weight ratio is low, as the hump drag will then become of considerable importance. The approximate value of the effective coefficient of friction for various conditions may therefore be summarised as below:—

Condition.	Effective Coefficient of Friction.
Metal wheel on rail	0.01
Aircraft wheel on ship's deck	0.02
Aircraft wheel on concrete runway	0.025
Aircraft wheel on grass aerodrome, normal surface	0.05
Aircraft wheel on grass aerodrome, poor surface	0.07
Flying boats taking off water	0.22

The very high value of the effective coefficient of friction for a flying boat (almost ten times greater than for a land plane on a concrete runway) explains the difficulty of obtaining good take-off for boats at high wing loading. To a certain extent this high value of effective μ is offset by the greater distance that is available for take-off, but in certain cases, such as operation from restricted harbours, this relief does not apply.

Take-off Distance

The effect of the variables discussed above will now be considered with respect to the actual take-off distance. To show the effect of flaps and airscrew conditions, Fig. 7 has been plotted for a series of hypothetical designs for long-range land planes. It is assumed that the all-up weight will be fixed by the take-off condition, the aircraft being increased in weight until the specified take-off run is reached, while the external geometry is kept the same so that wing loading will increase in proportion to the all-up weight. The increase in weight will not necessarily all be available for increased disposable load, as part of it will probably be used to strengthen the structure and maintain design factors.

Curve 1 is for the fixed-pitch airscrew of Fig. 5, curves 2, 3 and 4 for the airscrews 1, 2 and 5 of Fig. 5 at 10 per cent. above normal r.p.m. used without flaps, while curves

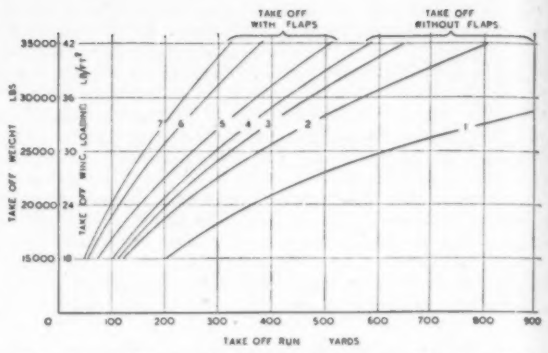


Fig. 7.—Influence of airscrew-engine conditions and of flaps on take-off mean.

6, 7 and 8 are for the same airscrews used with low drag flaps. The effect of flaps on the take-off with a fixed-pitch airscrew is not shown as the thrust/weight ratio is too low to give any appreciable advantage from their use. As explained before, the airscrews of curves 3 and 6 (Fig. 7) are appropriate to the two conditions of flight—300 m.p.h. at 25,000ft. at maximum efficiency or 250 m.p.h. at 5,000ft. with a 3 per cent. drop in efficiency. The difference between curves 2 and 3 and 5 and 6 represent the effect of stratosphere flight on the take-off, for the airscrews of these two conditions are designed for a maximum efficiency at 5,000ft. and 25,000ft. respectively. It will be seen that the high-altitude airscrew gives an appreciable advantage in take-off run or, alternatively, in weight at take-off. A still further advantage can be obtained by designing the high-altitude airscrews for a 2 per cent. drop in efficiency, giving the curves 4 and 7. In addition, it has already been shown that the wing loading for optimum cruising at 25,000ft. is considerably lower than for normal altitudes. This will, therefore, lower the take-off speed and give a further advantage to the high-altitude aircraft.

It will be seen that for a given take-off distance the difference between the weight at take-off of this series of aircraft, made possible by the use of variable pitch airscrews used with low drag flaps, represents the difference between a normal aeroplane and one which could undertake transatlantic flight.

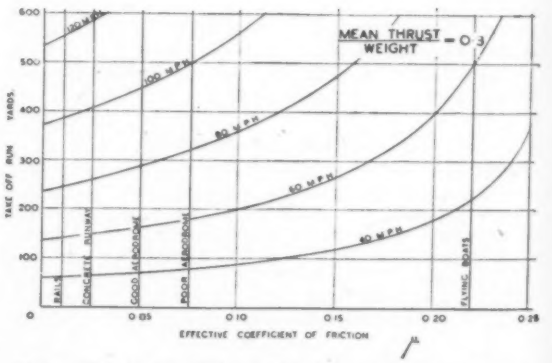


Fig. 8.—Effect of coefficient of friction and take-off speed on ground run.

A similar series of curves could be drawn for an increase in wing loading at a constant all-up weight. In this case the increase in take-off distance with increase in wing loading would be slower as the thrust/weight ratio would not be decreased with increase in wing loading as it is in Fig. 7. The curves would, however, be of the same form.

The effect of the coefficient of friction μ on the take-off distance is shown in Figs. 8 and 9, in the former of which the third variable is take-off speed, the thrust/weight ratio

being constant, while in the latter thrust/weight is varied for a constant take-off speed. Both sets of curves are of similar shape, showing the increased effect of μ as the length of run is increased. The difference between the take-off distance for a flying boat at an effective μ of 0.22 and a land plane on a grass aerodrome is shown to be considerable, the former being about twice the latter for short runs, the proportion increasing very rapidly as the take-off speed is increased or the thrust/weight ratio decreased.

One method that has been suggested to overcome this disadvantage of the flying boat is to mount the boat on a trolley running on steel rails and allow it to accelerate under its own thrust up to take-off speed. The saving in distance may then be very considerable as the difference in effective μ will be approximately from 0.22 to 0.01, and as will be seen from Figs. 8 and 9 it should be possible to launch a boat in, say, 300 yards, which is not able to take off under its own power from water. It is believed that some American experiments are being made on these lines, but no details are available. The disadvantages are that the ground space covered would be considerable, as at least two intersecting tracks would be required to avoid the danger of a side wind take-off.

The effect of concrete runways may also be seen from Figs. 8 and 9, and it will be noted that the advantage in

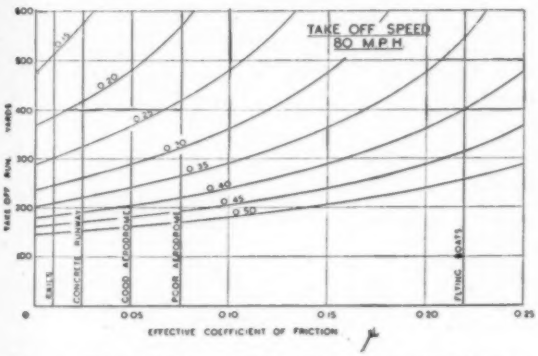


Fig. 9.—Effect of take-off speed and T/W on ground run.

take-off distance is small until the ground run becomes considerable. Thus, from the point of view of take-off run it appears to be uneconomical to put down runways unless the size of present aerodromes can be considerably increased. This is not to say that the use of concrete runways on normal-sized aerodromes is condemned, for they can show several practical advantages, particularly in wet climates where grass aerodromes soon become waterlogged. Higher tyre loadings might also be adopted if the use of runways became general, as there would then not be the present danger of sinking into the aerodrome surface. A reduction in tyre sizes would assist considerably in the design of large aircraft, where the difficulty of providing stowage for large retractable wheels is now becoming considerable.

Methods of Assisted Take-off

Full use of the devices previously described allows of a considerable increase in wing loading at take-off, but cases will still occur in practice, particularly in long-range aircraft, where a normal take-off is not possible at a wing loading as high as is desirable. In cases such as this some method of assisted take-off may be considered.

There are at present three main methods which may be used, namely:—

(i) Accelerated take-off.
(ii) The use of an auxiliary aircraft for take-off (Mayo scheme).
(iii) Fuelling in the air.

(i) *Accelerated Take-off.*—A considerable amount of data now exists on accelerators and catapults used for launching aircraft. Most of the work in the past has been done on medium-sized aircraft with normal take-off characteristics, the object being to launch an aeroplane from a restricted space such as a ship's deck. The accelerations used have been comparatively high and the take-off speeds of the aircraft used have been low, both of which factors tend to shorten the length of runway required. Accelerators for use with modern, long-range aircraft must deal with aeroplanes of considerable all-up weight and high take-off speeds, so that the difficulties have been considerably increased. The difficulties, however, are mainly those due to increase in the power of the accelerator and the increased length of runway required, and there seems to be no reason to doubt that these could be overcome as they are simply problems of heavy engineering.

Accelerated Take-off

In an accelerated take-off the aircraft is mounted on a carriage to which an approximately constant acceleration is applied by means of a ram, wire ropes or some similar method, the aircraft being accelerated up to, or preferably slightly beyond, its take-off speed so that it will be in flight at the end of the run. An alternative method if low acceleration is to be used is to allow the aircraft to run normally on its undercarriage and to apply to it an accelerating force by some means, such as a wire rope haulage system. This latter method will probably not be adopted for heavily loaded aircraft, but may be of use in assisting the take-off of an aircraft in a slightly overloaded condition.

For passenger aircraft the accelerations must be kept low, and it is probable that accelerations of the order of 1½ g. will not be much exceeded, although little information appears to be available on the maximum acceleration that can be used without alarming the normal passenger. It would appear that the rate of change and duration of the acceleration are of more importance than the actual maximum value reached, so that it may be desirable gradually to increase the acceleration to a maximum somewhat higher than 1½ g. and then decrease it until take-off is obtained.

High Acceleration

For military aircraft or commercial freight carriers higher accelerations may be imposed, thus reducing the length of runway required for a given take-off speed. High accelerations, however, will impose large loads on the structure and will, therefore, necessitate an increase in structure weight, and it is therefore probably more economical to increase the cost of the catapult by using a longer run with a lower acceleration rather than reduce the disposable load of the aircraft. Variable-pitch airscrews will be necessary to ensure a safe rate of climb after launching, and if used in conjunction with low drag flaps will materially assist in reducing take-off speed, and hence the length of run. To obtain an idea of the length of run required we will assume that the wing loading of the most heavily loaded aircraft to be launched at low accelerations is 60 lb. per sq. ft. By the use of V.P. airscrews and low drag flaps a C_L at take-off of at least 2.4 may be expected, giving a take-off speed of approximately 100 m.p.h. Allowing a margin of 10 per cent. the catapult design speed will be 110 m.p.h. and the length of accelerating run at a mean acceleration of 1½ g. (to allow a maximum of 1½ g.) is approximately 100 yards. The maximum all-up weight of the aircraft to be launched is more difficult to predict, but it may be expected to be at least 60,000 lb. for economical transatlantic flight, in which case the mean accelerating load will be 75,000 lb. Thus it will be seen that the use of accelerators for the type of aircraft which may be expected in the future will involve a considerable outlay in capital and will, in addition, require a considerable amount of aerodrome space, as it is probable that at least four directions of launch will be required to avoid the danger of side-wind take-off. On the other hand, depreciation and the cost of operation should be small and the maintenance required negligible in comparison with aircraft practice. The life of an accelerator may be expected to be long, so that in considering a design for large aircraft it will be necessary to allow for the requirements of aircraft which may be built in, say, the next 10 to 15 years.

(ii) *Use of an Auxiliary Aircraft for Take-off.*—The Mayo scheme for transatlantic operation is now well known and the first flights of this aircraft will be watched with interest both at home and abroad. In this method a small, highly loaded aircraft for mail carrying is taken off by means of a larger, lightly loaded machine. The transatlantic mail carrier is mounted on top of the parent machine and the two take-off and climb together. When sufficient altitude has been reached the two are separated and the smaller aircraft continues its flight while the parent machine returns to its base. In the parent design the upper component is a float seaplane, while the lower is a flying boat very similar to the "Empire" flying boats, but with considerably reduced load. The advantage of this method is that the operational aircraft need not be designed for take-off, so that this limitation on wing loading is removed, and, in addition, the use of V.P. airscrews may be avoided. The lower component, apart from the special attachments, is a normal flying boat and may be used for charter work when it is not required for launching the transatlantic aircraft. The disadvantage of this scheme appears to be the limitation in all-up weight imposed by the requirement that the operational component must be carried by the parent aircraft. This method, therefore, appears to be confined to the medium-sized mail-carrying type of aircraft.

(iii) *Fuelling in the Air.*—A very convincing display of fuelling in the air was given at this year's Hendon Air Display, and the method by which a drogue is used to draw in the fuel pipe to the aircraft to be fuelled appears to remove many of the difficulties to be expected when fuelling is attempted at comparatively high speeds. For transatlantic or other long-range aircraft this method might be used to reduce the limitation in weight imposed by take-off requirements, for the aeroplane would then take off with a small quantity of fuel in the tanks (say, a minimum of half an hour allowance) and the tanks would be filled in the air from the tanker aircraft. With transatlantic aircraft, where about one-third of the all-up weight of the aircraft is made up of fuel, this method would obviously show a considerable advantage and would allow a large increase in wing loading to be made while still maintaining a normal run at take-off. The disadvantages are that the amount of fuel that has to be transferred will be so large (a normal transatlantic machine may require from 2,000 to 3,000 gallons of fuel) that a considerable time will be required to complete the fuelling and the size of the tanker will be comparable to that of the transatlantic aircraft itself.

Summary

The main points of the paper may be summarised as follows: A consideration of the optimum wing loading for cruising leads us to the conclusion that for modern, clean, high-performance aircraft the wing loading could with advantage be considerably increased to loadings of the order of 60 lb. per sq. ft., or even higher, if the two main restrictions of landing and take-off could be eased. For normal, medium-range aircraft of fairly low power loading the most serious restriction limiting the loading to a lower value than is desirable is the landing run. With the present type of flaps this appears to impose an upper limit of wing loading of about 30 lb. per sq. ft. for land planes, 35 lb. per sq. ft. for flying boats and 40 lb. per sq. ft. for land planes with a front wheel undercarriage.

With long-range aircraft the landing condition is eased due to the consumption of fuel, and the take-off limitation then becomes severe. The effect of this limitation may be reduced by the use of high-thrust airscrews working in front of low drag flaps or by one of the methods of assisted take-off.

The device of designing an airscrew for a lower speed than normal and allowing a small drop in efficiency when cruising gives a considerable increase in take-off thrust and reduces the value of two-speed gears.

With high-altitude flight there appears to be no difficulty in obtaining a reasonable take-off distance as the take-off thrust may be expected to be higher and the wing loading lower than for an aircraft designed for flight at normal altitudes.

An examination of the generalised take-off equation shows that little advantage in take-off run is to be gained by the use of concrete runways until runs on the ground of the order of 600 yards can be allowed.

TAXYING BUMPS

*Some Comments on Mr. Corner's Criticism**

By A. E. PARKER, B.Sc.

(1) I should like to point out to Mr. Corner that the object of my article was to draw the attention of stress men and designers to the large accelerations which *might* be produced by bumps. I have never seen any reference to this subject before and most stress men seem unaware that a small bump could produce such large accelerations. It is obvious, however, that a non-rigid aircraft would not be subjected to such large accelerations as mentioned in my article. Here, perhaps, I may be allowed to quote from my article. In fact, when writing of the acceleration of 1282 g. caused by a bump of 1 in. and length of 6 in., I wrote: "This acceleration would necessitate a tremendous load on the undercarriage of the aircraft and on the aircraft itself, but in all the above examples it has been assumed that the undercarriage and tyres do not deflect. In practice, however, the undercarriage and tyres do deflect, so that the centre of gravity of the aircraft is not raised very much when the aircraft passes over a bump and hence the large loads previously found do not occur. In fact, considering the last example, where the bump had a height of 1 in., the tyre deflection alone would easily absorb the shock of this bump." Mr. Corner does not appear to have read this. However, the article was written to arouse interest, and I expected some correspondence on the subject.

(2) Mr. Corner in my opinion, has made a mistake at the beginning of his article. He says that the effective mass of the aeroplane in the vertical plane is M $(1 - q^2)$. Now there is no such thing here as "effective mass," unless one is dealing with Einstein's Theory. The quantity above is the effective *weight*, the mass remaining the same, i.e., M. Mr. Corner's equation:

$$M(1 - q^2)\left(g + \frac{d^2w}{dt^2}\right) = T = Mg\left(\frac{z_0 - z}{z_0 - z_1}\right)$$ is therefore incorrect. It should be:

$$M\left\{g(1 - q^2) + \frac{d^2w}{dt^2}\right\} = T = Mg\left(\frac{z_0 - z}{z_0 - z_1}\right)$$

Fortunately, however, these two equations reduce to the same value when q is zero or very small, and this is one of the assumptions of Mr. Corner.

(3) Mr. Corner assumes that the normal deflection of the shock-absorbing strut is 6 in. Now, I feel that this is large even for a large machine as, in order to absorb the shock of a landing at 15 ft. per sec., the undercarriage would have to deflect by about 2 ft., that is, of course, assuming that Hooke's Law holds for this case. I believe that modern undercarriages are made so that their characteristics are different for landing and taxying. As a matter of interest I have calculated the load produced by the bump of 1 ft. height and length 60 ft., assuming that $z_0 - z_1$ is one-tenth of a foot and the result is 1.645 Mg., which is *larger* than the value produced on the rigid undercarriage, which is 1.32 Mg.

(4) The effect of damping has been omitted from Mr. Corner's investigation, and I feel that this should be taken into account before it can be used for design calculations, as otherwise misleading and erroneous results will be produced.

(5) Mr. Corner has assumed that the results of static tests can be applied to dynamical cases. I feel that this is not true

* The Aircraft Engineer, November 18, 1937.

and, in fact, in practice the deflection of the undercarriage would tend to lag appreciably behind the statical effect of the applied load. It is also reasonable to assume that the load on an undercarriage depends not only on its deflection, but also on the rate at which one attempts to close the oleo leg. This effect is analogous to the well-known phenomenon of inductance in alternating current electricity. It would be possible to make an undercarriage leg such that the load on it did not depend on deflection, but only on the rate of closing of the leg. There is a note on the initial rate of closing of undercarriage oleo legs in A.P. 970 (1930).

(6) In conclusion, it is obvious that if Mr. Corner's results are correct, then no undercarriage failures should ever occur, and since they do occur, there must be something wrong somewhere. Mr. Corner has only considered one value of $z_0 - z_1$, which is rather large for most machines and why his loads are somewhat small. He has also assumed that the characteristics of undercarriages when taxying and when stationary are the same. This is doubtful.

In view of the above considerations and allowing for the fact that I had no experimental data on undercarriages, I do not think that the assumptions used in my article were unduly drastic, especially when the article was written chiefly to interest readers of *Flight* and to draw attention to the large loads which *might* be produced by bumps. The article was certainly not written to provide load factors. However, Mr. Corner's notes make a very interesting applied mathematical study, and if he could introduce the effect of damping and also use the results of actual taxying tests, his article should prove of real practical use.

Revised calculations of Mr. J. Corner's article.

With the same notation as used in the above article, we have :

$$T = Mg\left(\frac{z_0 - z}{z_0 - z_1}\right) = M\left\{g\,(1 - q^2) + \frac{d^2w}{dt^2}\right\}$$

also :

$$\frac{d^2w}{dt^2} = \frac{d^2z}{dt^2} + \frac{h}{2}\left(\frac{2\pi v}{\lambda}\right)^2 \cos\left(\frac{2\pi vt}{\lambda}\right)$$

$$\therefore M\frac{d^2w}{dt^2} = Mg\left(\frac{z_0 - z}{z_0 - z_1}\right) - M\left\{g(1 - q^2)\right\}$$

$$= Mg\left\{\frac{z_0 - z}{z_0 - z_1} - (1 - q^2)\right\}$$

Substituting in the differential equation :—

$$\frac{d^2z}{dt^2} - g\left\{\frac{z_0 - z}{z_0 - z_1} - (1 - q^2)\right\} = -\frac{2\,h\pi^2v^2}{\lambda^2}\cos\left(\frac{2\pi vt}{\lambda}\right)$$

i.e.,

$$\frac{d^2z}{dt^2} + g\frac{z}{z_0 - z_1} = g\frac{z_0}{z_0 - z_1} - g(1 - q^2) - \frac{2h\pi^2v^2}{\lambda^2}\cos\left(\frac{2\pi vt}{\lambda}\right)$$

Solution of this equation is :

$$z = z_1 + (z_0 - z_1)q^2 + A\cos\sqrt{\frac{g}{z_0 - z_1}}\,t + B\sin\sqrt{\frac{g}{z_0 - z_1}}\,t - \frac{2\,h\pi^2v^2}{\lambda^2}\cos\left(\frac{2\pi v}{\lambda}\right)t \Big/ \left(\frac{g}{z_0 - z_1} - \frac{4\pi^2v^2}{\lambda^2}\right)$$

Since $z = z_1$ at time $t = 0$ and $\frac{dz}{dt} = 0$ at time $t = 0$, it follows that B = 0 and that

$$A = \frac{2\,h\pi^2v^2}{\lambda^2} \Big/ \left(\frac{g}{z_0 - z_1} - \frac{4\pi^2v^2}{\lambda^2}\right)$$

and the final solution of the differential equation is therefore :—

$$z = z_1 + (z_0 - z_1)q^2 - \tfrac{1}{2}\cdot\left\{\frac{h(z_0 - z_1)}{\frac{g\lambda^2}{4\pi^2v^2} - (z_0 - z_1)}\right\}\left[\cos\left(\frac{2\pi v}{\lambda}\right)t - \cos\sqrt{\frac{g}{z_0 - z_1}}\,t\right]$$

The value of the maximum load due to the bump is :—

$$T_m = \tfrac{1}{2}\frac{Mg\,h}{\left\{\frac{g\lambda^2}{4\pi^2v^2} - (z_0 - z_1)\right\}}\left\{\cos\left(\frac{2\pi v}{\lambda}\right)t - \cos\sqrt{\frac{g}{z_0 - z_1}}\,t\right\}$$

where the maximum value of the trigonometrical term is to be determined. Mr. Corner did not explain how he does this, but it follows that if the trigonometrical term in the { } is to be a maximum, then :—

$$-\frac{2\pi v}{\lambda}\sin\left(\frac{2\pi v}{\lambda}\right)t + \sqrt{\frac{g}{z_0 - z_1}}\sin\sqrt{\frac{g}{z_0 - z_1}}\,t = 0$$

i.e.,

$$(1)\ \ldots\ \sqrt{\frac{g}{z_0 - z_1}}\sin\sqrt{\frac{g}{z_0 - z_1}}\,t = \frac{2\pi v}{\lambda}\sin\left(\frac{2\pi v}{\lambda}\right)t\ \ldots\ (2)$$

and the value of t to give this result can be found by drawing graphs of the two expressions (1) and (2) and noting where the curves intersect.

Long Travel

Mr. Corner assumes that $z_0 - z_1$ is 6 in., which appears to be very large, since the aircraft, in order to absorb a landing at 15 ft./sec., would need to have a total vertical travel of somewhat more than 2 ft. This is a very large value. I have assumed that $z_0 - z_1$ is $\frac{1}{10}$ ft. (i.e., 1.2 in.) and have calculated the value of the maximum load due to a bump of height 1 ft. and having a length of 60 ft.

Using the method previously mentioned, it appears that the trigonometrical terms are a maximum when $\frac{2\pi vt}{\lambda}$ is 84° 24′ and $\sqrt{\frac{g}{z_0 - z_1}}\,t$ is 145°.

Maximum load due to bump is therefore :—

$$\frac{1}{2}Mg\,\frac{\{\cos 84°\ 24' + \cos 35'\}}{(.379 - .1)} = \frac{1}{2}Mg\,\frac{.9191}{.279} = \underline{\underline{1.645\ \text{M.g.}}}$$

This value is actually *more* than the value obtained by assuming a rigid undercarriage, which is 1.32 Mg. This is partly due to neglecting the effect of damping.

TECHNICAL LITERATURE

Mainly for Students

Aerodynamics, by N. A. V. Piercy, D.Sc., M.I.C.E., M.I.M.E., F.R.Ae.S., The English Universities Press, Ltd., price 30s. net.

THIS book extends the work of the late Mr. H. Glauert (The Aerofoil and Airscrew Theory) not only by adding more up-to-date information, but by presenting the subject matter in a form which is probably more suitable for the use of the student, for whom the book is primarily intended.

It opens with chapters dealing exhaustively with the physics of the atmosphere, followed by Bernoulli's equation, and the significance of Reynolds Number. The next chapter deals usefully with a description of wind tunnels and the methods of carrying out experimental work therein, including examples of the effect of Reynolds Number. Then follows an elementary chapter on the aircraft in steady flight which pre-supposes a knowledge of the airscrew characteristics (which are not dealt with until much later in the book).

In the following chapter, the author leaves the practical application of the art to explain the fundamentals of irrotational flow, vortices and wing theory, the latter as applied to both monoplane and biplane. This part of the book also includes sections on tunnel constraint and the work of Joukowski.

Viscous flow and skin friction follow next, with approximate solutions to some of the more complicated problems. This chapter also deals with the effect of turbulence and roughness.

Airscrew theory and its application to the flight of the Autogiro are dealt with near the end of the book, when the aerofoil and vortex theories are properly understood.

Then follows some performance calculations, based mainly upon the work of Bairstow and Durand, and the final chapter deals with stability in flight.

Dr. Piercy is to be congratulated on the thoroughness with which he has dealt with most of the subject matter.

If an author is prepared to go deeply into each branch of such a subject as aerodynamics, the work must become voluminous. No person as busy as Dr. Piercy can afford so much time, and so his book had to be cut. Where and how to cut must always be a matter of some dispute. The present reviewer, with some knowledge of the requirements of industry, suggests that the information given is not sufficient to equip the graduate with a working knowledge of modern methods of performance estimations. For instance, nowhere in the

book is any reference made to span loading, nor is any expression developed for the power expended in overcoming induced drag such as

$$\text{T.H.P. } \sqrt{\sigma} = \frac{K}{V}\left(\frac{W}{S}\right)^2 (1+\delta).$$

Similarly, although some suggestions are made about estimating performance, using the skin friction as a basis, the student is given no idea as to the use of a form plus interference factor for the aeroplane as a whole, let alone the magnitude of such a factor. In the reviewer's opinion, it is a mistake to advocate the estimation of parasitic drag in terms of so many pounds per square foot of frontal area; modern aeroplanes do not fall in line with collected data and require a technique of their own.

It is rather surprising that so little use has been made of the admirable experimental work carried out by the N.A.C.A. In spite of the fact that 78 aerofoil tests, including those on six symmetrical ones, have been published in a single work, Dr. Piercy remarks on page 357 that "Further tests of this nature would be valuable," in reference to the N.P.L. tests on Kármán-Trefftz aerofoils. Probably 90 per cent. of the modern aircraft are using N.A.C.A. sections and, so far as the reviewer knows, none employs Kármán-Trefftz types.

On page 363 one is advised to make a separate estimate of drag at climbing speed to allow for the change in Reynolds Number, but on page 377, after calculating carefully the time of flight (for range), one is informed that "when this is done and allowance made for the operational difficulties t_o may amount to little more than one-half what it would be if optimum values could be maintained." To the designer, knowing the difficulty of predicting climb, the former advice would seem unnecessary, and the latter for the student requires amplification

There are a few phrases which must be a little confusing to the student; for instance, on page 116 we have the following, which needs no comment: "However, the useful load of such aircraft would be small, and one-half of the supposed power equipment considerably exceeds the economic limit with present-day aeroplanes intended for high-speed transport, which must be aerodynamically efficient (it may be noted here that the product of the lift-drag ratio and the airscrew efficiency is sometimes called the aerodynamic efficiency of the craft)."

On the whole the book is excellently arranged and written, but Dr. Piercy has attempted to crowd into one volume sufficient subject matter for two. Shortage of space has compelled him to curtail sections, which makes the book more suited to the student and research engineer than to the designer.

W. R. A.

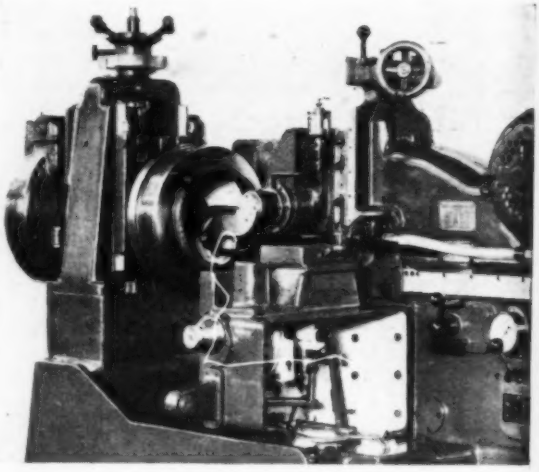
Precision in Gear Grinding

FOR many years past the final grinding of aero engine gears has been part of the work of the Gear Grinding Company, of Handsworth, Birmingham, and at the present time some twenty machines, many being of the firm's own design and construction, and using the formed-wheel method, are employed in finishing Rolls-Royce Merlin and Kestrel gears and splined shafts.

There are some striking facts about limits and the profile of gear teeth For example, certain reduction gears have three measurements per tooth or six between the gear and pinion, the limits being within 0.0002in. The teeth themselves are ground 0.002in. from the shape required in operation and they become true under normal load.

With special "Orcutt" machines of their own manufacture the firm are able to grind internal teeth, an operation which, it is claimed, they alone can carry out and which is necessary, for example, in finishing the teeth engaging the coupling between the crankshaft and reduction gear on Rolls-Royce engines.

An instrument for measuring the involutes of gear teeth has also been developed by the Gear Grinding Company. It is probably the only one of its kind, and the design provides for ease of change from one job to the next, and accuracy unaffected by the weight or size of the gear within certain limits. Direct readings are given in 10,000ths of an inch.



Internal tooth-grinding by the form-wheel principle—using the periphery instead of the edge or side of the grinding wheel—on an "Orcutt" machine by the Gear Grinding Co.

Stressed-skin Construction

MR. W. TYE, B.Sc.(Eng.), some little time ago contributed an article to *The Aircraft Engineer* (August 26) on "The Distribution of Loads on Stringers and Transverse Rings in a Monocoque Fuselage." His views have since been challenged by a reader, Mr. M. M. Gololobov, and Mr. Tye now writes in reply, as follows:—

"I am indebted to Mr. M. M. Gololobov for his useful criticism of my article. The formulæ given for the loads on stringers and rings were calculated on the assumption that the skin was so thin that there could be no direct shear stress on the skin. In practice both the skin and the stringers may take a portion of the total shear load as direct shear stress, but the actual value of this proportion is difficult to assess.

"An approximate method of making allowance for this effect is suggested as follows: Under the given system of externally applied loads the distribution of shear stress round the fuselage section is calculated using the simple 'engineers' theory of bending (no wrinkling in the panels). In this calculation, if the fuselage is tapered, an allowance is made for the fact that the end loads in the stringers (due to bending of the fuselage) have components in the plane of the fuselage cross-section, which resist shear load directly. The critical stresses, which will just cause shear wrinkles to form in individual panels, are next found. R. and M. 1553 may be of use in this calculation. The magnitude of the external loading necessary to cause wrinkling to commence in the various panels is thus known. As the external load increases past a certain minimum value, first one and then an increasing number of panels become wrinkled. Once wrinkling has started in a solitary panel the critical load at which each successive panel wrinkles becomes more uncertain. For safety's sake therefore, it is assumed that all the load applied above this minimum wrinkling is acting on a fully wrinkled shell. The formulæ quoted in the article may then be used, working with this excess load instead of the total shear load."

Information on Alloys

THE establishment of an aluminium information bureau, with London headquarters at Bush House, W.C.2, has been announced by the Northern Aluminium Company, Ltd., of London, Birmingham and Banbury, well-known producers of aluminium alloys for aeronautical work.

The purpose of the bureau, which is under the management of Mr. D. Cannon Brookes, M.A. (Cantab), will be to gather and co-ordinate all information regarding all the uses and application of aluminium and aluminium alloys in this and other countries, and to offer a comprehensive industrial and general enquiry service.

Its further activities will include the initiation of special research by recognised authorities into the existing and potential uses of aluminium alloys in all fields, and also research into industrial and domestic trends so far as these affect the aluminium industry.

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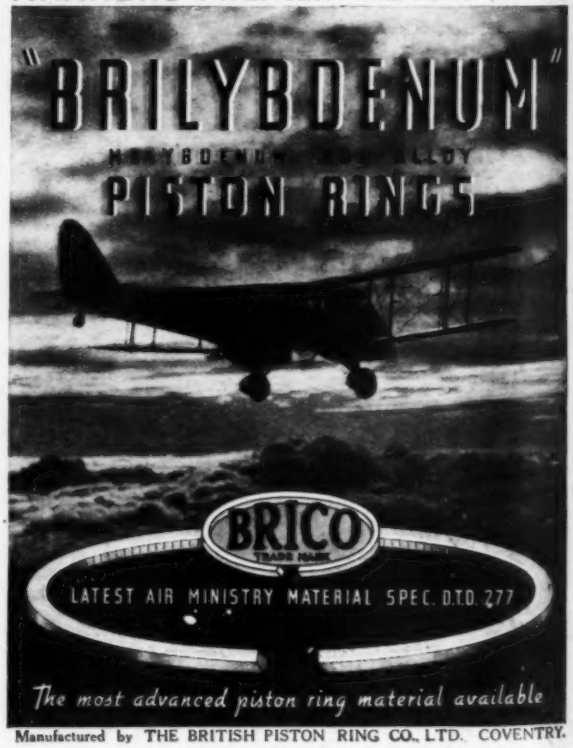

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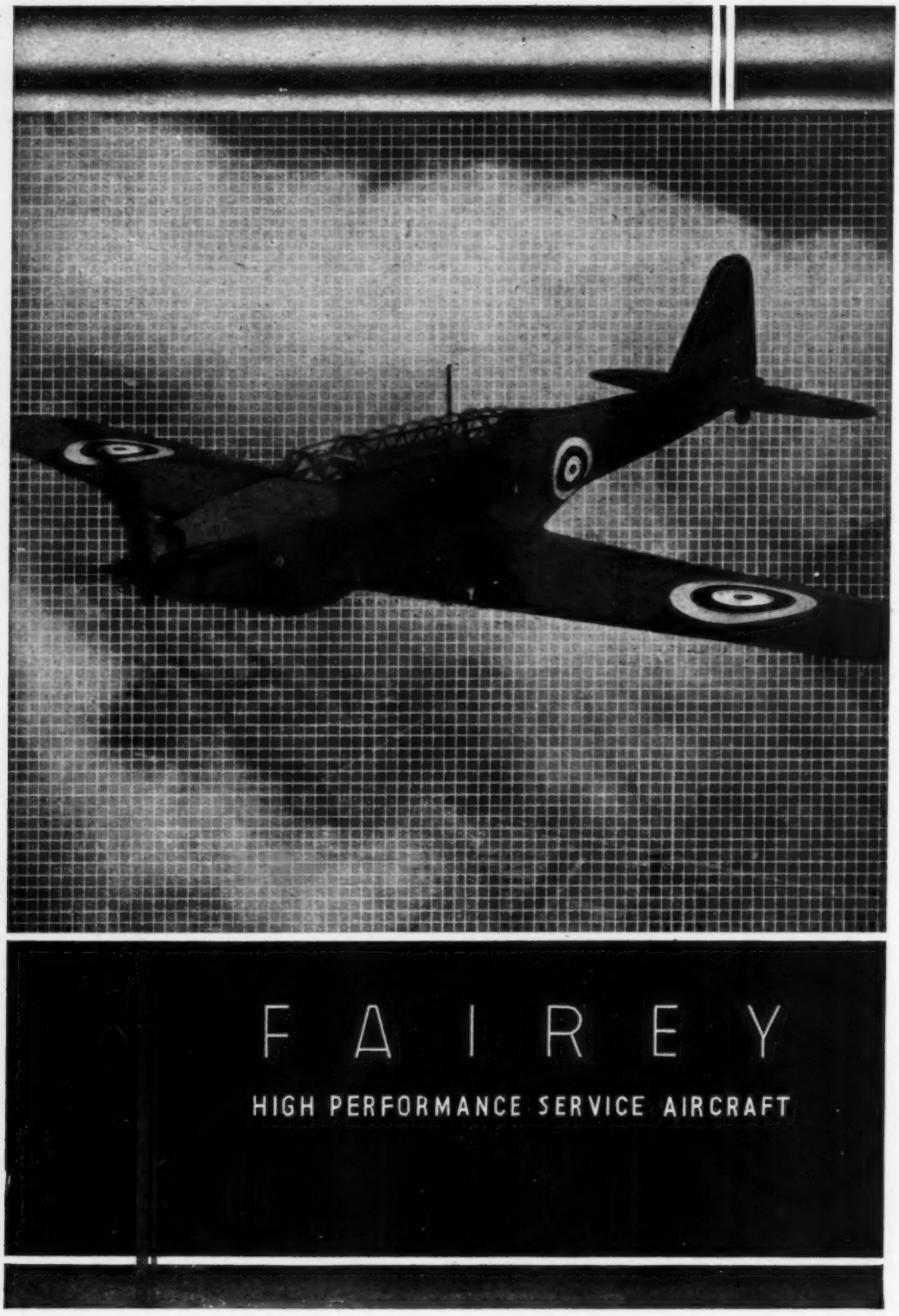

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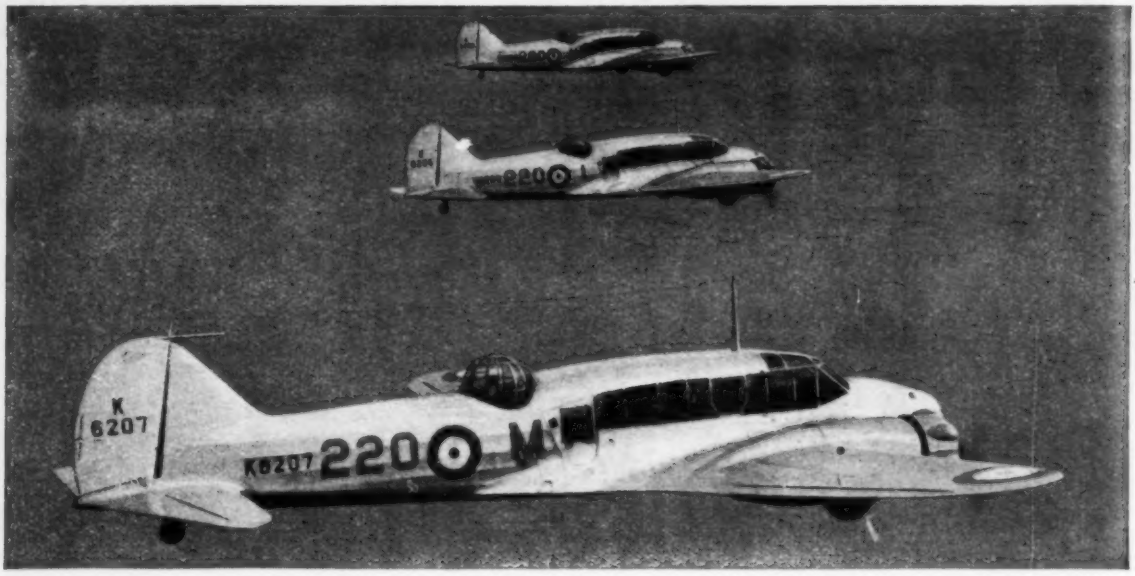

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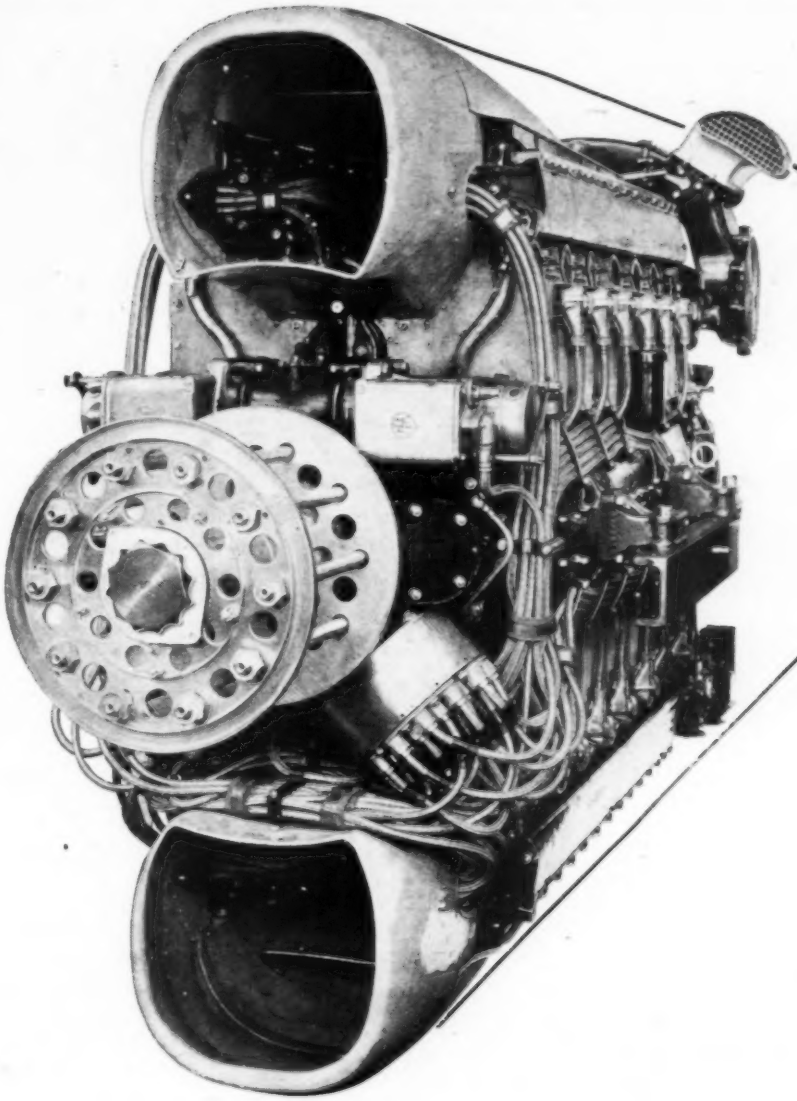

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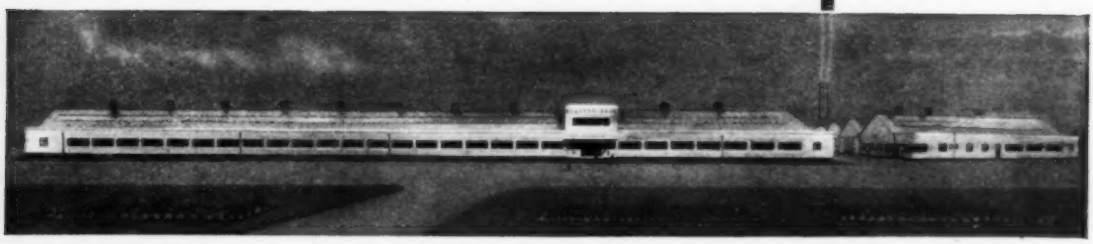

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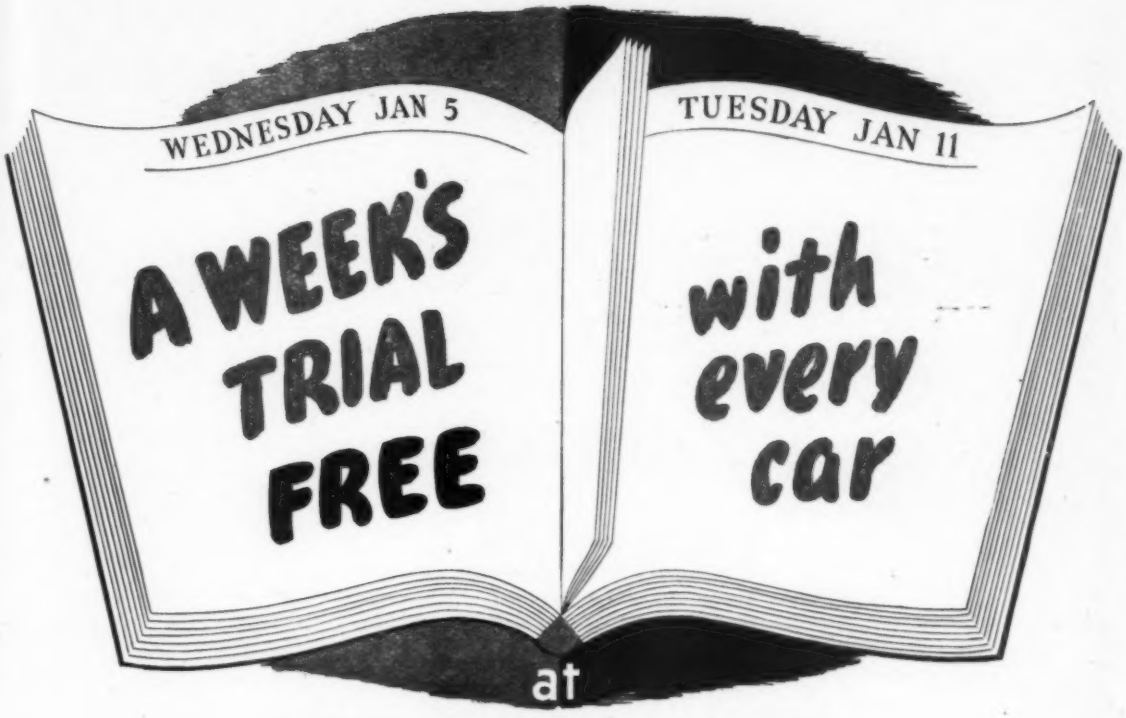

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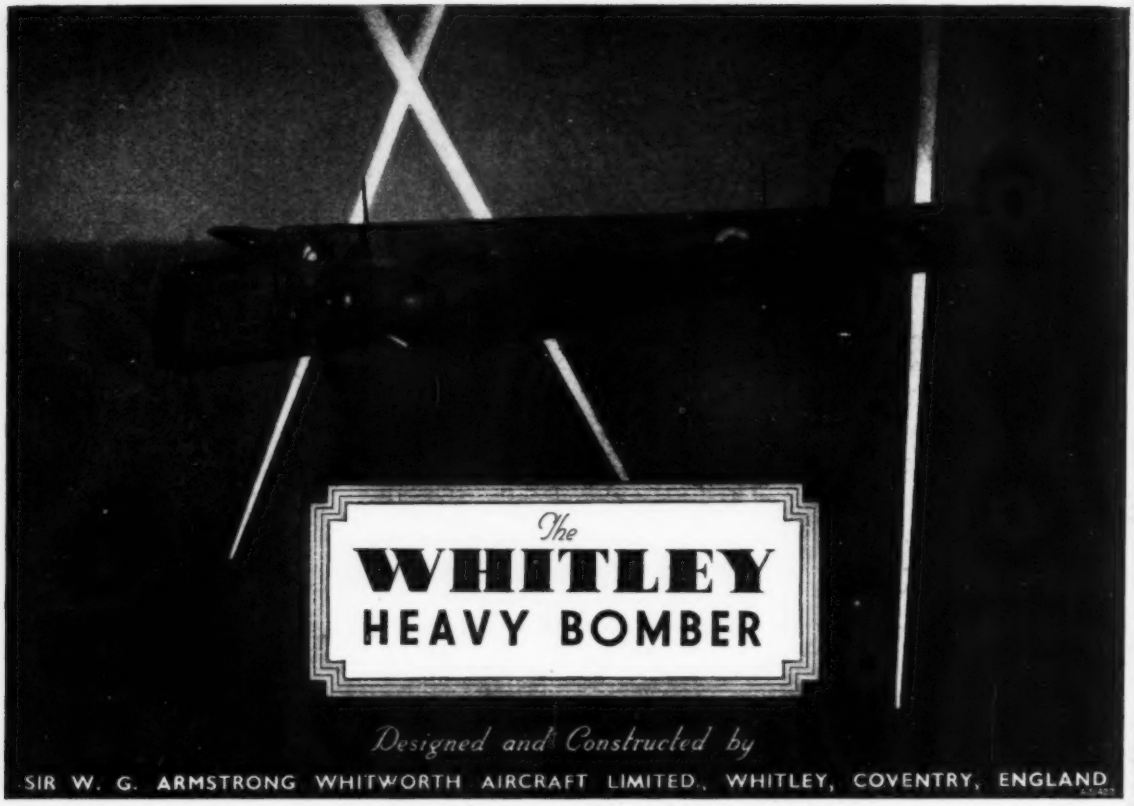

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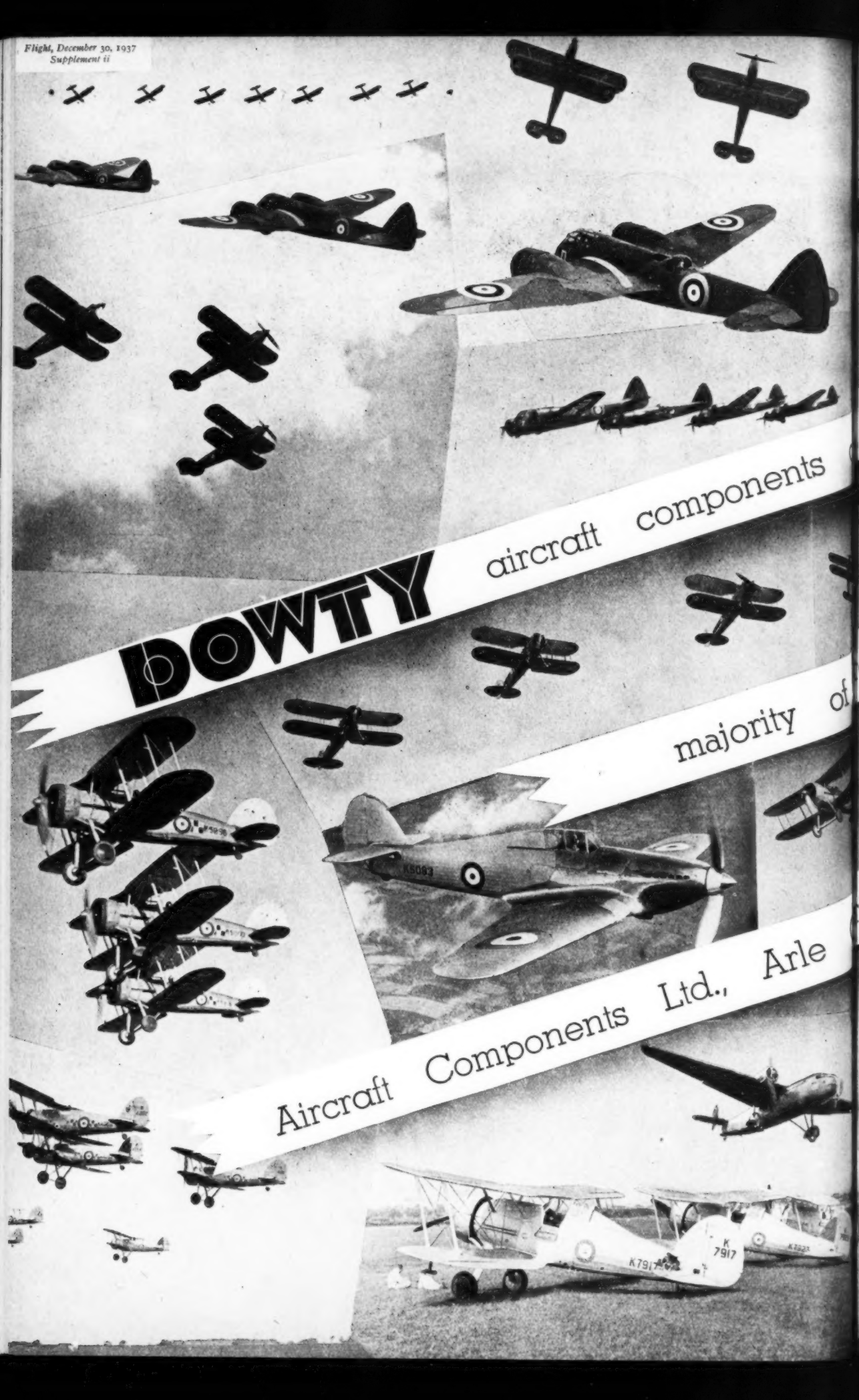
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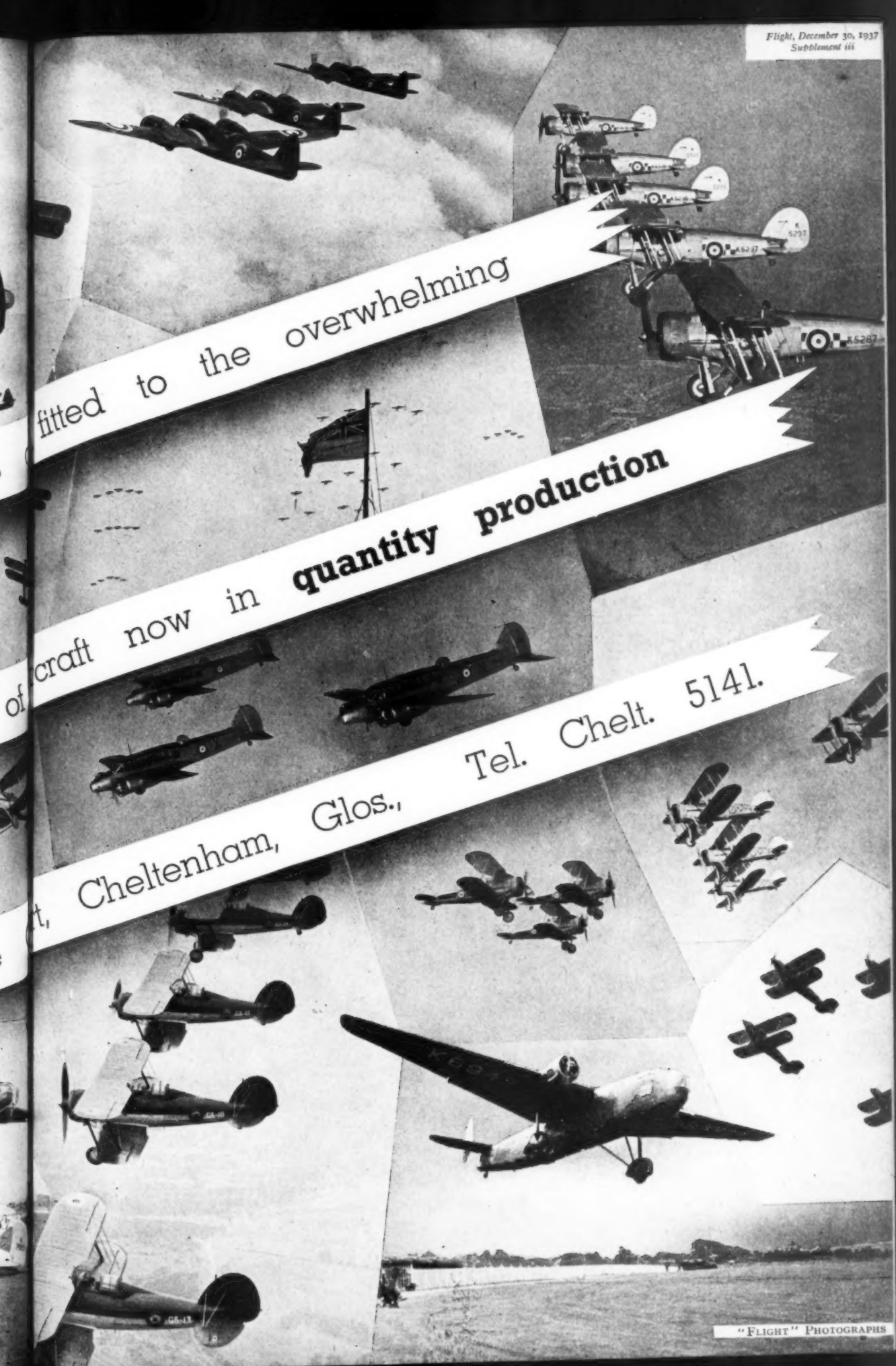
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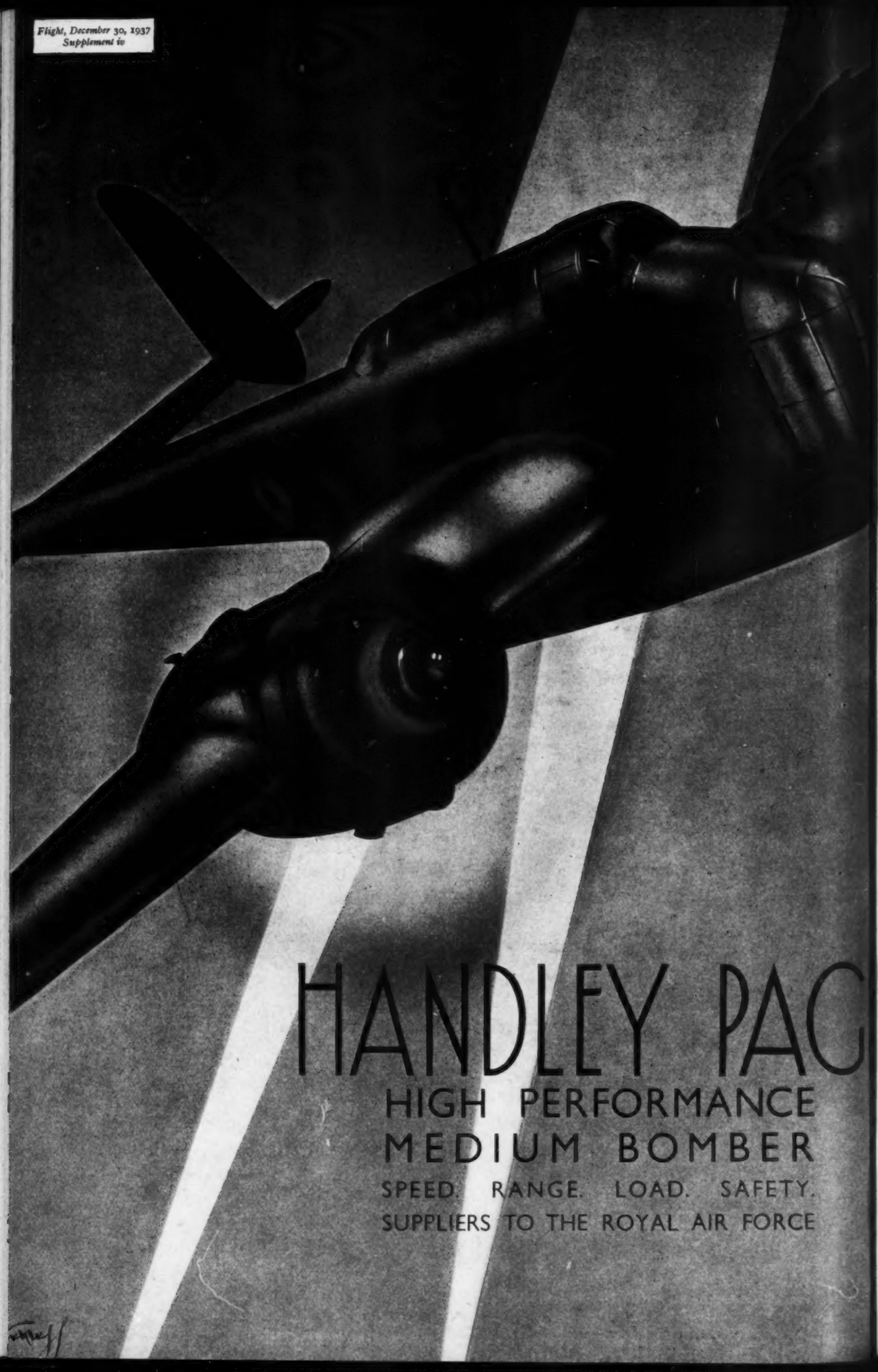
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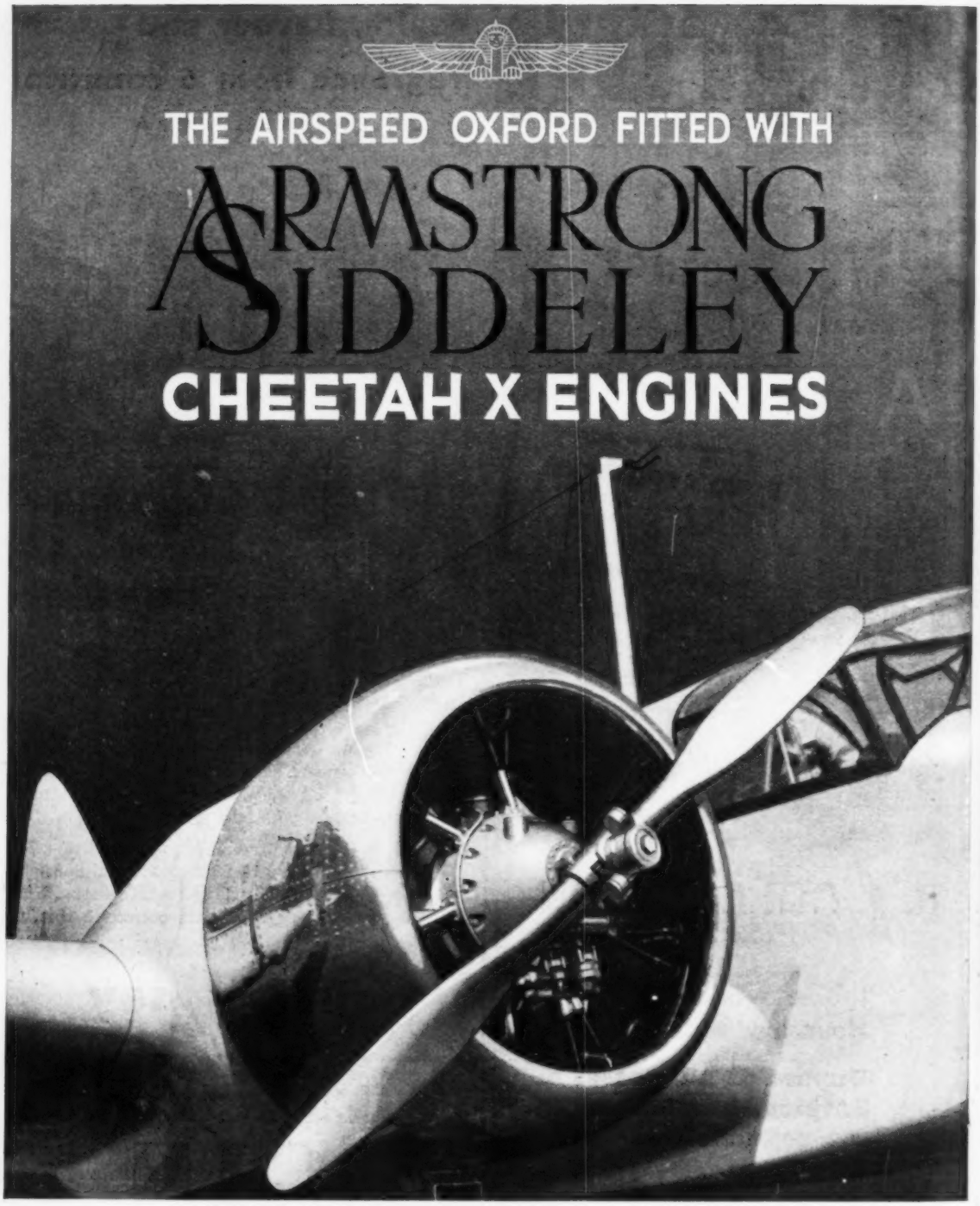

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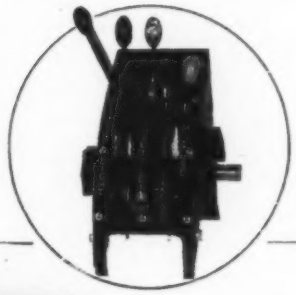

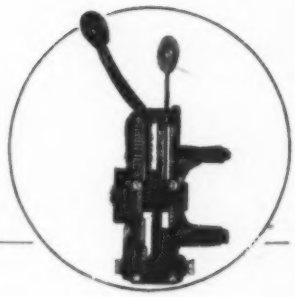

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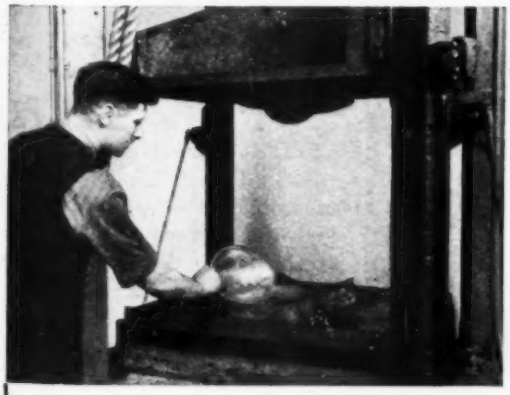

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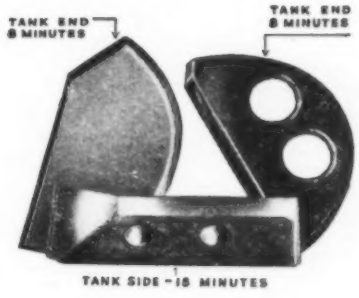

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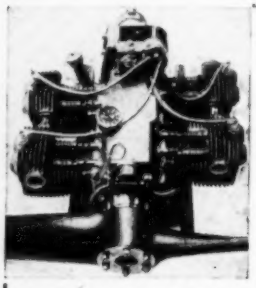

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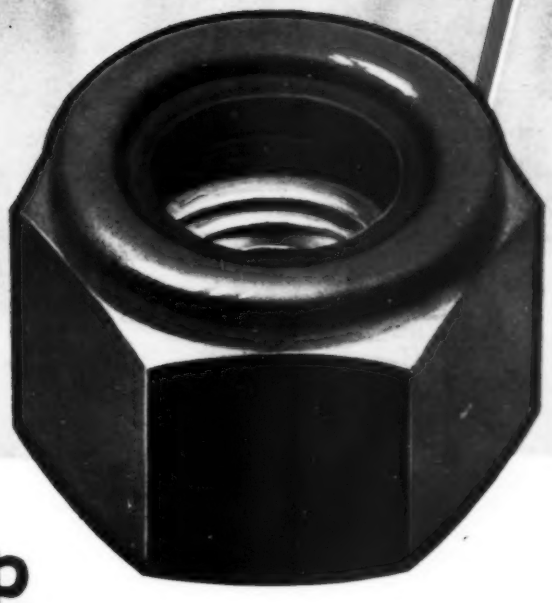

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